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ABSTRACT

This book, intended for use by inservice teachers, preservice teachers, and parents interested in open classrooms, contains three chapters. "Beginning Reading in an Open Classroom" discusses language development, sight vocabulary, visual discrimination, auditory discrimination, directional concepts, small muscle control, and measurement of abilities. "Beginning Math in an Open Classroom" describes stages of math development, activities for developing math skills, and evaluation of pupils' mathematical skills. "Five Children: Case Studies" presents the case studies of five children to illustrate how diagnosis and learning strategies were initiated. A conclusion discusses the lack of patterns in the development of a child's learning. Three appendixes describe evaluation procedures for math and reading, and the selection and use of classroom materials for math and reading. (WR)

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Teaching in an Open Classroom

Informal checks, diagnoses, and learning strategies for beginning reading and math

By Nancy Langstaff
Cambridge Friends School
Cambridge, Massachusetts

Foreword by Edward Yeomans

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February 1975

National Association of Independent Schools
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CONTENTS

FOREWORD by Edward Yeomans v

BEGINNING READING IN AN OPEN CLASSROOM 1

Notes on the Reading Checks - 8

How the Reading Checks Were Administered - 9

BEGINNING MATH IN AN OPEN CLASSROOM 10

Notes on the Math Checks - 13

How the Math Checks Were Administered - 17

FIVE CHILDREN: CASE STUDIES 19

Barbara - 19

Bill - 24

John - 32

Nikki - 39

Sylvia - 45

CONCLUSION 53

APPENDIXES 57

A. A Description of the Reading Checks - 57

B. A Description of the Math Checks - 61

C. Notes on the Selection and Use of Classroom Materials for Math and Reading - 63

BIBLIOGRAPHY 70

FOREWORD

It is interesting to look through any recent bibliography on the open classroom and notice the change in authors that is taking place. Most of the early reports by American writers are based upon their observations in English primary schools or their conversations with teachers about the work that was observed. Increasingly, the lists include reviews of their own work in the classroom by teachers in the midst of practicing the art. This is a healthy change, and Nancy Langstaff has made a valuable contribution to it.

Nancy Langstaff teaches a class of 24 five-, six-, and seven-year-olds at the Cambridge Friends School, in Cambridge, Massachusetts, a school that has adapted the principles of open education to the realities of an American community. The school as a whole pays respect to individual differences among students and teachers alike, but it also has expectations and a structure for achieving them. This report provides an inside view of one teacher and her class, showing some of the ways educational expectations are implemented in an open-structure classroom.

The title of Nancy Langstaff's book leaves out much that is found in its pages. To be sure, her children's first steps in learning reading and mathematics are the central area of interest, but so too are their first steps in learning how to learn. By drawing upon the research of Piaget and others concerned with the learning process itself, she builds a solid structure of diagnostic information about each child. This information, in turn, guides her in making decisions about timing, pace, and content of curriculum, and provides her with expectations that are then either verified or modified as the months go by. It is a good example of the kind of structure that is needed in classrooms that have moved beyond the simplistic and often harmful patterns of conventional grading and testing.

Children in a vertically grouped classroom such as this one have the advantage of a second and perhaps a third year with the same teacher. This arrangement could lull a teacher into the hope that some of her children's problems would be solved by the mere passage of time in her room. Not so in Nancy Langstaff's case. The checks and records she keeps could guide another teacher as well as they guide her during the second or third year. Clearly, this is the kind of responsibility that will build respect for the broad concepts of open education.

Nancy Langstaff's book has much to offer to teachers: not as prescription, but as suggestions for ways of knowing individuals. It could also be helpful for parents who view with concern the expanding patterns of open education in their schools. Teachers of Nancy Langstaff's ability are much needed in the process of training other teachers, for open education requires this kind of reality. Her book is a long step in the right direction.

Edward Yeomans
Greater Boston Teachers Center

BEGINNING READING IN AN OPEN CLASSROOM

My conception of how children learn to read has been influenced by my experiences in an informal, mixed-ages classroom. More and more I have come to believe, based on my own classroom observations, that children are not merely taught to read, but (in spite of what the teacher may think) make the necessary connections, in their own style, when they are ready--by themselves. If this is so, it affects what the role of the child is in the reading process as well as that of the teacher. The child is the active participant; it is his* own learning that achieves the result of reading. He has to make the leap from symbols or single words to meaning; from fragments to coherent sentences.

What is the role of the teacher, then? It is first to provide an environment rich in learning materials, experiences, and activities; next, to ascertain when the child is ready for additional reading tools (when he wants and needs them), and what kinds of tools will be most helpful to him, given his strengths and weaknesses. Then, to help him acquire these skills, using his own powers of discovery, discrimination, and analysis, as much as possible. In this way, the tools come to belong to the child; he has made his own connections. This takes skill on the part of the teacher: skill in choosing what to offer and in what order, skill in calling forth cognitive responses. I think of this way of teaching reading as emphasizing the discovery process for the child.

But what takes place before the child is at the critical stage where he is ready to master these beginning skills? First and foremost is the development of his oral language. The informal classroom has countless opportunities for encouraging the growth of this ability. There is the constant, conversational interaction between children, not only in free play, but also in solving problems. Dramatic play is encouraged, and one often sees a group of five-year-olds in our house corner acting out imaginative episodes. Class discussions involve not only the expressions of thoughts and feelings, but of ideas ("Why do swans float?"). Interaction with me as the teacher often includes explanations of why things work or of what is happening.

These language experiences are stretching for children, who continually find new ways of expressing themselves, who learn new words from me or other children, who begin to find new ways of looking at things. In addition, my reading aloud to our assembled class is an important part of every day. Reading aloud helps to bridge the gap between oral and written structures, which differ more than most of us are aware, and enriches the child's own language with new words and thoughts. Children become involved with the story-reading through discussions, comments, and questions, which make a lively interchange of ideas. Our story times also include learning poems by rote, for the

*In order to avoid awkward constructions, the masculine pronouns are used and are intended to refer to both girls and boys.

pleasure of the sounds and images, or chanting traditional favorites like "This is the house that Jack built." We also sing songs. Rhyming songs, such as "A-Hunting we will go," in which the children make up their own rhyming verses, are immensely popular, and soon even the youngest are joining in (and, incidentally, learning new words and developing an ear for sound similarities).

The children are also constantly exposed to the written word. Labels abound in our room; everything from the pencil box to the yardstick has its own sign. Messages are hung in many areas: "Only three children at the milk and cracker table"; "No standing on the tower"; "Corner for quiet play." Signs are also posted daily on the bulletin board, telling who goes to music or sports and at what time; asking questions: "How many round things can you find in the room?" or "Do you need to glaze your clay?" There is also a name board, where each child hangs an attendance tag on his own hook. The younger children sense that signs give information they want to have--another motivation to learn to read. Although new children can't read these signs at first, the other children enjoy helping them out. Soon even the youngest children begin to use clues to decode the signs: "Music begins with an 'M,' and I see my name on the sign."

By the end of the kindergarten year, most children can read all the names in the class (which I regard as an astonishing feat) and know what almost all the signs say. I also tape up sheets with words for songs and poems we have memorized so that the child can have the pleasure of connecting his sung or chanted words with their written equivalents. Thus the child is picking up an instant sight vocabulary, as well as confirming the fact that words refer to specific objects or ideas.

There are many opportunities for developing other abilities important to reading and writing readiness: visual discrimination, auditory discrimination, directional concepts, and small-muscle control. Since the children in our open classroom are encouraged to choose many of their own learning activities, a variety of things typically take place at the same time. Therefore, it is important to provide an assortment of learning materials that children can use independently, or in spontaneous, self-directed groups. Once a child has learned to use a game or structural material, he often likes to show it to other children, leaving me free to work with small groups or individuals.

Visual discrimination and a sense of spatial relationships can be stimulated by using tangrams, parquetry pieces and design cards, pegboard arrangements, and games that require matching similar pictures or patterns. The children, who use these materials freely, are often unaware that this is helping them to build the ability to discriminate between sets of configurations (such as letters or words) and to cope with their placement in space (as on the printed page).

Auditory discrimination, which is vital to the use of phonics, is woven into many of our activities. We play rhyming games, with children making up the rhymes (nonsense words are thoroughly enjoyed); we do rhythmic "copycat"

clapping (which requires both coordination and retention of auditory patterns); we play "guessing" games that involve the isolation of beginning, ending, or middle sounds of words ("Can you think of something that ends with the same sound as 'dog'?"). Children of all ages like these games. Readers and nonreaders mix happily to play them, in groups of two or three.

Directional games are also helpful in developing a young child's spatial orientation. I use singing games for some of these ("Left hand on your head," etc.). Board games, like Parcheesi, which require moving in a certain direction, are also excellent for increasing the directional sense (so necessary in reading from left to right). We also find weaving on small cardboard looms particularly useful in sorting out directional confusions.

Small-muscle control and dexterity, necessary for writing, grow with the constant use of art materials in our room (paint, clay, crayons, scissors); with sewing projects, such as embroidery or making puppets; in carpentry, with plenty of sawing, sanding, and hammering; and in cooking, with tiny measurements of vanilla, soda, or salt. Construction games also help to build dexterity: small pieces must be fitted together with precision or delicately balanced.

"We're making different kinds of stars with pattern blocks." (Age 5)

At different stages, children become intrigued with the prereading games available on the classroom shelves that combine auditory, visual, and often tactile approaches. These games involve matching pictures with beginning letters of words; matching pictures with beginning sounds; matching letters and sounds; matching blends; and matching words with similar spelling patterns. For these activities we use dominoes, lotto, and card games. Older children frequently play with younger ones, helping them where necessary. The older children also play other word games, designed for competent readers (such as word-building games that use cards with root words, prefixes, and suffixes) with me as a challenging way to build additional skills.

Into this daily fabric are woven the child's own stories. Five-year-olds help make their own picture-story books. They usually start off by drawing a picture, then dictate their own stories, at times of their own choosing, and see me transform their words into written symbols, which are then read back to them. Often the child will recognize several words or ask what one means. Thus the relation between their own language and writing and reading is immediately obvious; words are not something alien in a printed book.

Since the children are encouraged to dictate in sentences (not word by word), they early get the "feel" of what a sentence is (a useful precursor to punctuation). Older children write down their own stories, asking for words when they need them (which they put in their personal "dictionaries"). Other words are "sounded out," and I respect the child's individual spelling (as long as we both can decipher it), knowing that familiarity with conventional spelling through reading and special practice sessions will soon correct many of these errors.

I can hardly overemphasize the importance of the child's own writing. Not only is it a creative experience, often accompanied by splendid drawings and startling stories, but it is also a social, learning process. Children usually write stories near their friends, with much talking, sharing of words, listening to dictation, or reading over one another's shoulders. Children don't compare themselves with other children in the same way they would if they were reading from the same primer. The precocious five-year-old is challenged by writing and reading her own stories; the timid seven-year-old can "tell" about his pictures. Each is making a unique contribution by sharing his thoughts and drawings. With so much contagious excitement about writing stories, the children's own books become an important part of our classroom reading material. Despite the variety of books in our reading corner, from "beginning readers" to reference books, by far the most popular, thumbed-through, and discussed stories are those written by the children themselves.

Another important influence in our open classroom that shapes the direction reading takes is having the children record their work, pictorially or in writing, to help both the child and me keep track of activities. A five-year-old draws a lima bean, then the plant at various stages; a six-year-old adds words: "My bean did not grow today." The seven-year-old may dispense with the drawing and write, "My plant is two inches taller than last Monday." This continuous recording, on different levels, spreads through the entire

life of the classroom, with sharing, appreciation of various efforts, reading one another's information. Children become eager to know the symbols that will enable them to write. They press me to help them, first by dictating information that I write down for them, then by trying to do it themselves. Thus, the child's own curiosity opens an important avenue for teaching skills.

A popular activity with both five- and six-year-olds is making their own "sound books." The child decorates a cover and I staple in blank pages. Whenever he wants to, the child draws a picture of an object (a snake, for example) in his book. He decides the sound it begins with, and I write the letter for this at the top of the page, which he traces over. I also write the word "snake," which he can "read," under his picture. There is usually a good deal of excitement over these "sound books"; the child, having chosen his own pictures, remembers the sounds and often the printed words that go with them, thus connecting his own language with sounds and symbols. There is also a great deal of learning through sharing: "What did you draw? What sound is that?"

"I am reading to my friends. I like to read a lot." (Age 6)

When a child seems motivated to read and write and has developed small-muscle control, directional sense, and spatial, auditory, and visual discrimination, and when he can attach sounds to letters of the alphabet, he is usually ready to make rapid and satisfying progress in reading and writing. Because his prereading experiences have been so rich and varied and have permeated his activities, the more formal use of skills comes easily, as a continuation of what went before.

No line is drawn between my teaching of writing and reading and the use of readiness materials. It is all integrated, thus tending to make it a simple process. Since the child already knows his letter sounds and symbols and has played some blending and rhyming games, and because he has built up a sight vocabulary from his own dictated stories and signs in the room and has begun to try to write on his own, the first easy books he reads are basically confirmations of what he has learned. They are a revelation, not a struggle.

A child who has learning disabilities often needs, in addition to the activities mentioned above, a different approach. Here I am fortunate in being able to consult with a reading specialist. In a flexible classroom one can also modify one's approach to suit a child who has, for example, auditory weakness and needs more emphasis on a controlled sight vocabulary, or to help the occasional child who needs a great deal of repetition and regularity and benefits from practice in structured workbooks.

Since my emphasis is on writing skills (which spring from the child's interest in his own picture stories and sound books), the reading comes by itself sometime during this period as a surprising and exciting reward. Skills may be taught in small groups, which shift and re-form as often as the need arises, or individually (most often a combination of both). They are always adjusted to the pace or needs of the children. The only timetable I have is theirs. The child who needs lots of extra time can take it comfortably; the child who learns rapidly pushes ahead; the child who isn't ready or interested can wait. (I realize that I have a huge advantage in being able to put the child first; many schools have curriculums that must be adhered to, regardless of a child's readiness or pace.) Also, within this framework, the individual child's learning style is respected, and his strengths and weaknesses are taken into account. For each step there are a variety of ways to present the material. For example, either auditory or visual modes of learning can be emphasized, with kinesthetic reinforcement, still with children using their own powers of observation, analysis, and discovery.

Following is a brief description of the skills I usually teach beginning readers.

1. The first step is to form lower-case letters, associating their sounds with the beginning sounds of familiar words: "F has the sound that you hear at the beginning of 'fast.'" The child has already had an introduction through the sound books. This goes on concurrently with the use of readiness games.

2. Soon the child begins to blend two letters (usually a consonant and the short-vowel sound ă), both by writing and reading them back.

3. Next the child blends three-letter words, writing them down. When this has become easy, using the short ă, other short-vowel sounds are introduced in the same way. The words we use are familiar in the child's own vocabulary, such as "hot," "got," "not." As the child reads his words back he becomes aware of patterns and rhymes, which provide additional reinforcement.

4. Meanwhile, a few crucial sight words are introduced for instant recognition, such as "is," "the," "on," "has."

5. Soon the child can write and read back simple sentences. At this point he is also able to read beginning phonic readers. Practice continues, with my dictating sentences for the child to write. He must listen, decode, write, then read back--a complex series of skills.

6. Next consonant blends are introduced for the child to sound out, analyze, and use (such as tr- at the beginning of a word, or -nd at the end).

7. Consonant digraphs are introduced (such as sh and ch).

8. Next vowel combinations (such as oa or ai) or the silent e at the end of a word that result in a long-vowel sound are introduced. Here, as in the above skills, the child is encouraged to discover relationships for himself. "What happens to 'hat' if you add an e at the end? What happens to 'bit'?" Eventually the child makes a generalization and tells me the "rule."

These skills, which usually take a full year for a child to assimilate, may be learned in a mixed-age group at any age between five and eight years, depending on a child's readiness. The individualized approach means that the child is not exposed to failure. He is less apt to compare himself with another child when there is such a variety of activities connected with reading. He also uses the phonics skills in personal ways, at his own level of readiness, sounding out words when he reads back dictations, when he deciphers signs, when he writes his own stories. The group work merely fosters the process by focusing on the tools. (Continuing skills work for children who have assimilated this material and are secure early readers is not described here, since we are dealing with beginning reading and writing.)

When a child who has learned to write picks up a "real" book and finds he can read ("I didn't know I could read this book!"), it is exciting for all of us. Even though he has been reading signs around the room, reading stories that he has dictated and that other children have written, looking at picture books, and gaining writing skills, somehow none of that seemed like "reading." With such rewarding beginning contacts with books, these children are off to a good start in becoming enthusiastic, independent readers.

Notes on the Reading Checks

As a teacher in an open classroom, I felt the need to look more objectively at individual children and their learning strategies. I had been relying largely on intuitive judgments in my work with children; now I wanted to know some of the reasons why things worked or didn't work. I hoped that, as I learned to make clearer evaluations, I could become more critical of what I steered children toward and more effective in planning for their needs.

After considerable reading, I came to the conclusion that the best way for me to reach my goals was to look carefully at specific children, concentrating on areas of reading and math. I planned to study a group of five-year-olds who would be in my classroom again the following year, so that I could observe their development over two years.

First I went over my classroom notes about each child, looking for specific behaviors that related to reading abilities and writing up these observations. This was inspired by remarks in Jansky and de Hirsch, Preventing Reading Failure (1972), that observations by classroom teachers are important predictors of young children's success or failure in reading. I was also intrigued by the book's suggestions for informal, diagnostic tests to isolate reading abilities. I therefore followed those guidelines in making up simple reading checks I could use individually in my classroom. In preparing these checks, I consulted our school's reading specialist, Wendy Barnes, who was most helpful with practical suggestions for devising, administering, and scoring them. The abilities I wanted to measure were oral language, visual discrimination and perception, and pattern memory.

Oral language, which involves spoken-language ability as well as the ability to retrieve names and use categories, was checked by asking the child to tell a story based on picture cards (see Appendix A for detailed descriptions of all the checks); to name a series of pictures; to name several categories; and to repeat increasingly difficult sentences after me.

Visuo-motor skill, or eye-hand coordination, was checked by using the first six Bender Motor Gestalt cards and by noting how the child used a pencil and wrote his name.

Auditory discrimination and perception, the abilities to hear similarities and differences and to gain meaning from them, were checked by having the child repeat sentences, repeat tapped patterns, and by other tasks requiring sound discrimination and blending.

Visual discrimination and perception, the abilities to see similarities and differences and to gain meaning from them, were checked by using ditto sheets requiring word-matching and nonsense-word-matching, then by seeing if a child could recognize two words taught by sight.

Pattern memory, which overlaps visual and auditory activities, included all the checks requiring recall (blending, word recognition, sound discrimination).

All of this was followed by additional observations about the child's ability to listen, to understand directions, to concentrate, and to work independently.

How the Reading Checks Were Administered

I gave all the reading checks informally during afternoons in May when the children were otherwise engaged in free play. (I had already completed reading predictions based on classroom observations.) We used a secluded table in our classroom where we could work without interruptions. I prepared one check carefully and then gave it to each of the children involved. I chose a child who was temporarily unengaged and said, "I have something to do with you. It only takes a couple of minutes."

After several of these sessions, the children began to find this amusing and said, "Are we going to do another of your one-minute games?" They all seemed to enjoy the checks and, if the word got around that I had a new one ready, they had to be discouraged from lining up for a turn. Other children in the class asked to do some, too, so I made up extra sheets for them. All the children who were tested concentrated well at these tasks. I don't remember their ever asking how they did, and I never showed any completed checks to other children, so there was no comparison. In fact, there seemed to be no concern with any judgments about their performance. Rather, they concentrated on the task at hand--partly due, perhaps, to lack of emphasis on competition and comparison in the classroom in general, and partly to the "trying a new game" approach I used.

Since all of the checks are very short (none taking more than a few minutes), I can administer several to one child at a time, without eating appreciably into classroom time. This is especially a help when there are other children I feel I need more information about--particularly newcomers in the six- or seven-year-old groups.

During June, when I had completed the checks, I went over the results with Wendy Barnes. We looked at each child's strengths and weaknesses and decided to use gross scores of "high," "medium," and "low" (see Appendix A) to indicate the patterns of these abilities.

One check that I administered poorly was "tapped patterns"--poorly, because no one scored well on it, even though in similar classroom activities, such as copying clapping patterns, some children excel. I think that in the "tapped patterns" I didn't stress the differences between loud and soft enough.

Another sidelight on the checks was my personal involvement. I knew I had certain expectations for certain children. Therefore, I was scrupulous in presenting the checks in identical ways, and in refraining as far as possible from any comments. I was rewarded with some surprising results: one child whom I expected to do extremely poorly did astonishingly well; another whom I expected to excel did only fair work.

BEGINNING MATH IN AN OPEN CLASSROOM

Observing children in my mixed-ages classroom as they begin to explore mathematical relationships is a continual learning experience for me. As I watch five-, six-, and seven-year-olds using materials to count, sort, measure, and make comparisons, I realize that previous experience can be a powerful factor, and that the ages at which basic math concepts seem to be formed vary considerably.

I have discarded many preconceived notions about "teaching" mathematics in favor of presenting opportunities for children to discover relationships largely on their own. The word "discovery" has become a key one for me as I have watched children learn through their own experiences and their own discoveries. Each child gradually puts together concepts to order his world. He becomes increasingly able to think logically and to explore relationships. He does all this at his own rate of speed. Although teachers and parents can provide stimulation and even try to teach a child concepts, he has to arrive at these himself when he is ready to assimilate a new idea into the framework he has slowly been developing. Therefore, I have tried to become increasingly aware of each child's stage of readiness and to be on the lookout for opportunities to help children make connections and sort out relationships appropriate to that stage.

An important part of my role is preparing the classroom setting, taking cues from children's interest in gathering materials for independent "hands-on" exploration--a collection of shells that can be counted, classified, or ordered by size over a period of days, for example. The vital ingredient that makes this process work is the children's own curiosity and enthusiasm about doing and learning new things. It tends to have a pattern: first, a lot of manipulation or "messing around"; next, realizing some of the relationships or concepts involved; then, using the material in a more structured way, but still in free play; and last, using the material to solve particular problems. Each of these stages is important and seems to provide a necessary framework for the next.

Examples of different stages are shown in the use of the pan balance, with which the children experiment freely. How it works is something of a mystery to some children. I have seen a five-year-old who was haphazardly piling up an assortment of acorns, pebbles, and bits of styrofoam announce triumphantly that she has made it "balance." I look more closely and see that she has piled several blocks under the pans to keep them from tilting (a randomness not unusual for a beginning stage). At a later stage, the child will play with the balance, still piling on lots of things, but adding or removing objects in such a way as to keep the balance beam level. She has learned a lot about weight and balance on her own. Later, she may want to use the balance to weigh our gerbil, finding that it weighs as much as two erasers. The next year, she may use it to work out how many ounces a pint of water weighs, subtracting the weight of the container from the total.

A recent episode combined several stages of understanding. A group of five-, six-, and seven-year-olds spontaneously decided that they wanted to find out how many Unifix cubes there were in a box. They gave up counting by ones and tried counting by groups of 15, then 20. Both were too difficult. They finally settled on groups of 10 and made these piles all over a big table. They kept losing track of how many piles they had counted, so they numbered bits of paper and placed one beside each group, arriving at 37. Some children had helped make piles of 10; others helped count and number the piles; a couple more went on to figure out "Thirty groups of 10 are 300. Seven groups of 10 are 70. We have 370 cubes."

The youngest children like to count out the cups for milk, matching the number with the attendance tags. If the supply runs short, they figure out how many more cups I should get them. Or they may choose to measure a carefully nurtured seedling with bits of ribbon, to be pasted in a scrapbook, or to sort a jumble of beads, pebbles, and counters in the housekeeping corner into different containers for "supper."

Other sorting and classifying activities can be stimulated by bringing in new materials and displaying them in a central place. I recently collected a large box of wood scraps and suggested that a group of five interested children find out how many ways they could sort the scraps. They made piles of rough, smooth, large, small, heavy, light, thick, thin, long, short, dark-colored, and light-colored pieces. This caused animated conversation about who should collect a smooth piece that was also heavy and thick, or where to place a short dark-colored piece. When they had decided how they wanted to combine their sets, we made labels for each pile and discussed some of the other ways they could have done the sorting.

This particular activity progressed into carpentry. I asked children to draw a plan before building. I was struck by the difference in various children's ability to conceptualize and draw a plan, and was also struck by the fact that the children who did block-building, constructions, tangrams, or clay were much better able to present a coherent plan with a sense of spatial relationships than the children who avoided those areas.

Carpentry makes practical use of measurement, but many other kinds of measurement go on constantly in our classroom. Rulers, tape measures, trundle wheels, graduated containers, measuring cups and spoons are all available. The water and sand trays are sites of busy, voluntary activities that generate much conversation about amounts: "My jar holds more than yours does." "No it doesn't, because mine's fatter." "Let's measure and see." Cooking, a popular activity, is splendid for clearing up misconceptions about fractions because it tastes so awful if you make a mistake ("Is 1/4 cup one of four cups?"). Cooking also involves counting: if you have one pan of 11 cookies and another with 13, will there be enough for each child in the class to have one? Measuring one another's height is a periodic concern. Big sheets of paper on the wall work well to record heights. ("I'm taller than Susan but shorter than Jerry." "I'm exactly 3 feet 2-1/2 inches!")

Many children become enthusiastic about estimating and checking out their answers by using all kinds of measurement. Younger children may guess

that the rug is as long as 10 books, then measure and find out that their answer differs from that of a friend who used different books. I often make little blank books for children to write or draw their answers in; some children will fill up whole books with problems such as "I guess the pitcher holds 5 cups. I measured and it was 9." I encourage children to estimate first whenever possible, even problems in simple arithmetic, not only to encourage them to think, but also as a check, as they begin to think more logically, on the reasonableness of their answers.

Building towers with Cuisenaire rods is also popular. Younger children start with small, irregular "houses"; more experienced builders construct precisely graduated towers. In the process they learn the mathematical relationship of the pieces: which ones are longer and how much longer, which are shorter, how many of what color rods will match an orange one, and so on. When I introduce more formal strategies to small groups of children for using rods in addition, subtraction, multiplication, division, and fractions, they are usually picked up quickly and are frequently used for individual problem-solving, such as adding up long game scores. Some six- and seven-year-olds who have built up basic number concepts enjoy doing "missing number" problems,

"I am measuring how many cupfuls the tube is. I think it is 3 cupfuls."
(Age 7)

using rods to check their answers and often using their own individual notation to record their work. I try not to hurry this process, as I believe the doing is much more important than the recording.

Some children need to spend most of their time in the lower school working with materials before they are ready to use abstract symbols. As the need arises, or as the child's readiness and curiosity dictate, I introduce conventional mathematical symbols. Blank books are available for children to write their own problems in, using drawings, color codes, or numbers. The child who can make up and solve simple problems such as $5 + \square = 12$, or $\square - 6 = 7$, has a good grasp of beginning number relationships. The combination of free play and experimenting, with my help when a child seems ready for a new step, runs through much of our math work.

Many other spontaneous activities involving math take place in our classroom, from making scale murals of animals to playing "store." Playing "store," which is always organized by the children with only occasional help from me, usually involves writing out prices for the product (perhaps for pretzels the children have made); setting up a bank with paper money and "checks" for children to sign in order to draw out cash; and paying for the product and then counting up all the proceeds at the end. We can spend an entire morning doing this, with most of the children participating.

A variety of board games in our room provides excellent practice in arithmetic. The simpler ones involve direct matching of a dice throw with moves on a board; more complex games, such as Monopoly, require a good deal of adding and subtracting. The children use the games entirely independently, with those who know a game teaching it to others.

An endless number of mathematical activities, most of which result from the children's own interests and curiosity, seem to be threaded into our day. I try to foster this by providing setups that stimulate experimentation; by asking questions about how things work; by suggesting extensions of an activity, such as making a graph out of all the strips of ribbon used to measure a plant over a month. I also try to keep careful anecdotal notes about each child's use of games and materials to give me an over-all picture of what his number concepts are and in what directions he may need to be steered.

Notes on the Math Checks

If one believes that it is inappropriate to teach young children by rote, then it is also inappropriate to check their mathematical ability by tests using number facts. The only math tests I could find depended on these. I was more interested in finding out something about how five-year-olds approached or solved problems, what logical concepts they had formed, and what their idea of number was.

Using a Nuffield Mathematics Project booklet, Checking Up 1, which contains excellent ideas, I adapted some of its activities in order to check concepts of matching, counting, and seriation.

The first check involved using counters in various counting and trading activities (see Appendix B for detailed descriptions) to ascertain what the child's notion of one-to-one correspondence and conservation of number was at five years. I also used activities involving the terms "more than" and "less than," which are essentially operations performed on another number.

I also included tasks requiring a different kind of ability--that of spatial organization and discrimination--parquetry cards and tangram cards. Here the children manipulated geometric shapes and needed an awareness of the properties of these shapes and of their relation to the design in order to fit them together.

Another task suggested by classroom use was solving problems on the math balance, which was a new experience for these five-year-olds. Here the child needed to understand the concept of balancing. I was particularly interested in observing several things in his problem-solving: (1) Could he solve the problem on the first try? (2) If not, did he move in the right direction? (3) Did he resort to trial and error and then move in the right direction, or were his efforts random, with no concept of how to move the weights?

I also checked the children on their concept of the conservation of continuous quantities. I used Piaget's well-known setup of pouring liquid into containers of differing shapes or sizes to find out whether the children could grasp the permanence of the whole, or whether they thought the quantity changed if the number or size of the containers changed.

Checks involving classification and class inclusion were also based on Piaget's experiments. I adapted these from experiments in Piaget, The Child's Conception of Number (1965), and Inhelder and Piaget, The Early Growth of Logic in the Child (1969). Piaget's theories about class inclusion particularly interested me, not only because of what they indicated about the growth of the child's logical thought, but also because of the implications for teaching arithmetic. Piaget considers addition to be an operation that cannot really be understood until the concept of class inclusion is obtained. The child who is unable to grasp class inclusion is having conservation difficulties similar to those of the child who lacks the notion of conservation of continuous quantities or number. The whole no longer exists when it is broken up into parts; the idea of the total class is lost when the parts are considered. The child has not yet attained the ability to think "reversibly."

For the first class-inclusion check, I made a set of cards portraying four boys and three girls, and asked the children whether there were more children or more boys. (Before doing this, I borrowed Piaget's idea for a check to see whether the children understood the terms "some" and "all" so that, if possible, language difficulties wouldn't affect their understanding.) The child who was able to include the subsets of boys and girls in the wider set of children was using the concept of class inclusion. This was a simple experiment, perhaps because the words "boys," "girls," and "children" are so familiar. Also, the connection of boys and girls being children is a very

direct one; one perceives simultaneously that an individual is both a boy (or girl) and a child.

Next I did an experiment using nine orange and three blue wooden beads, and asked whether there were more wooden or more orange beads. All the children agreed that all the beads were wooden (the wider class) but were convinced that there were more orange than wooden beads, because what they saw were orange and blue beads. It was too much for these five-year-olds to hold the whole class in their minds while considering the parts.

Experiments with class inclusion have practical implications for the classroom teacher. Consider the difficulty of learning addition and subtraction if you cannot include the parts in the whole. If a child is considering a set of seven objects composed of four objects of one kind and three objects of another, and he can only compare the four objects with the three objects, then how can a teacher make addition meaningful? It seems as if it can only be taught by rote at this point, which is not only a waste of time but a way of leading to confusion in the child's mind. If the child doesn't have the mental structures that make sense out of the information, he won't

"We are playing with colored inch cubes and design cards." (Age 7)

see the relationships, even though he may memorize addition and subtraction facts and repeat them without understanding.

When it came to evaluating the children's work, I discarded the idea of using "poor," "fair," and "good" in favor of a developmental description. I was drawn to Piaget's "stages" as a guideline (Piaget, 1965). There are two factors to consider here. The first is that the child passes sequentially through each stage in developing a concept (such as conservation of number). The second is that there seems to be some variation in developing different concepts, so that one child may attain the concept of class inclusion while using a purely perceptual approach to conservation of discontinuous quantities, while another will gain the idea of permanence of continuous quantity but be unable to include the parts in the whole in class-inclusion tasks. Furthermore, as new concepts are encountered (even by adults), one often needs to go through the process of assimilating data and adjusting one's frame of reference so that they may become useful concepts. Thus, Piaget's stages, which seem to me a continuous, spiral process as the child develops, are not judgmental, but only indicate where he is at present in his logical thinking.

The first stage is known as the "preoperational period," the first part of which is called "preconceptual." It is characterized by the child's dependence on perception: a pile of stones has more in it than a pile of beans "because it looks bigger." It is also characterized by inflexibility and irreversibility of thought, as shown in the experiment with wooden beads. The child feels that, if he has mentally used up the orange beads as a set, they are no longer available as part of the larger set of wooden beads.

Piaget describes the second part of the preoperational stage as being intuitive. Here children rely on trial and error as well as intuition to arrive at their conclusions. Toward the end of this period a transitional stage that is an optimal one for teaching in a number of areas occurs: the child is in a state of disequilibrium, partly relying on appearances but ready to reconcile these with what he knows, sure at moments about a problem, confused or guessing at random, moments later, with the same task. If the teacher presents appropriate materials or setups (such as the water or sand try with different-shaped containers) and focuses the child's experimentation with appropriate questions ("How can you prove to me that this holds more?"), the child is ready to discover the relationships involved. It is important to remember that a child may be ready for one concept but not for another. The teacher should constantly be on the lookout for clues to this.

The third stage is that of concrete operations. Here the child relies on what is logically necessary, not on what he sees. His discoveries are immediate, there is no hesitation in his conclusions. He can also give reasons for his conclusions. The child can now think reversibly. He can consider the beads as orange at one time and wooden at another, or as orange and wooden. Piaget says, "What characterizes deduction is precisely the capacity to construct all possible combinations by returning every time to the starting point, and then comparing them as if they were present simultaneously in the mind" (1965, p. 178). Although the child is capable of simple abstract

thinking at this stage, he still often relies on and benefits from using materials, as the word "concrete" implies.

I did not decide to use Piaget's stages for evaluating my math checks until I had given all the checks. There was so much variation in each child's performance that a developmental description seemed the only valid way to assess the results.

How the Math Checks Were Administered

I gave the math checks individually to the children in our classroom during the late spring. I chose times when most of the children were out of the room, perhaps at sports or folk-dancing. We used a screened-off corner so that the child and I could work quietly without being interrupted, observed, or overheard by other children. Because we approached the checks in a relaxed way, the children viewed them as interesting tasks. If a child appeared to be tired or wasn't concentrating for some reason, I repeated the same check another day (usually with markedly similar results).

I prepared by writing out careful instructions for myself, including how to phrase my questions so that exactly the same words would be used for each child. Next, I tried out the checks on my family, who helpfully criticized any ambiguities of language or what they felt were "leading" questions. My next step was to try the checks with a few children from another class at school, using a tape recorder. I played these tapes to a colleague familiar with Piagetian research, who felt that the questions were sufficiently clear and objective.

Before checking the children in my own class, I made up a diagnostic sheet for each task so that a child's responses or activities could be quickly recorded. I continued to use a tape recorder for all the checks that required verbal responses, not only so that I could relisten to the child's answers at leisure in case I had missed a clue, but also to double check for lack of objectivity in my own questioning.

As with the reading checks, I was very much aware that a teacher's expectations can color the outcome. However, I had no particular investment in having one child perform more competently than another. I was simply interested in finding out more about each child so that I could teach him in the most realistic way possible.

"We are figuring out how much my pot weighs." (Age 7)

BARBARA
(5 years, 6 months)

Reading Predictions Based on Classroom Observations

Barbara will be interesting to follow because, at the age of five, she appears to be so entirely capable. She feels positive about herself and comfortable with both children and adults. She is independent, but asks for information or materials when she needs them. She concentrates well and will stick at a difficult problem for long periods of time, with no apparent anxiety--simply in an effort to work it out. On the other hand, she paces herself well, and if she has worked on a project several days running she will decide, "I don't want to do that any more," in a definite way. She follows directions well and expresses herself easily with a good vocabulary.

Barbara shows good auditory discrimination, as evidenced in identifying sounds and rhyming words. She learns words to songs easily and shows a good rhythmic sense in her clapping. Her visual discrimination is fine, and she has no trouble identifying similar symbols and letters. Her directional sense is well-developed.

During the year, Barbara has been continuously involved in prereading activities that involve auditory and visual discrimination as well as numerous projects involving spatial relationships and manual control. This spring, she has begun to practice writing lower-case letters and working out simple three-letter blends using the short ă. She is not highly motivated, but she enjoys the activity and retains it well.

I expect Barbara to learn to read and write easily and comfortably; maybe not rapidly, but securely. I think she needs to have her skills taught regularly at this time. Since she works well in a group, perhaps a group having similar needs can be formed in the fall after rechecking takes place.

Diagnosis and Recommended Learning Strategies Based on the Reading Checks

Barbara did outstanding work in most of the reading checks. Her oral-language abilities were uniformly high, with the exception of the sentence-memory check, which rated a "fair" plus (just missing "good" by the omission of one word and the repetition of another).

Auditory discrimination included two "fair" ratings: tapped patterns and sentence memory, again. Blending and sound discrimination were high.

Pattern memory was very good, and so was visuo-motor organization.

Barbara's storytelling in the oral-language-level check was concise, well-constructed, and demonstrated a good vocabulary. Her Bender Motor Gestalt designs displayed a fine use of space.

Barbara was the only child checked who answered the question "What is reading?" in a way that noted the correspondence between written and spoken words: "There are words, and you look at them and guess what they say."

The second part of the reading checks--the additional observations--confirmed the data collected on the first part. Barbara rated high in all areas.

Barbara is a child who is comfortable, capable and motivated to learn. A plan for her should include opportunities for a considerable amount of independent work, since she is clearly able to do this. When I say "plan," this is expressing it too strongly. What I expect is that she will be excited about learning to read and will seek out ways on her own to increase her knowledge. My part should therefore be to foster her initiative by helping her with the tools and skills she needs at appropriate times.

Barbara knows her short-vowel and consonant sounds and has begun to combine them into words. She has also learned to form many lower-case letters. It would help her to know how to form all the lower-case letters and to increase her blending skill by introducing consonant blends and digraphs by means of teacher dictation, which encourages her to figure out the sound-symbol relationships herself. Barbara would also benefit from introduction of common sight words she is apt to need for reading and writing, which could be done in a group of two or three other children who need instruction in similar areas. (Such groups as this, formed for a particular reason, should be disbanded when the skills are achieved or perhaps re-formed, with different members, for a different purpose later on. The group's duration would depend entirely on the pace of its members, and if the spread of abilities became too wide, there should also be interim regroupings.)

Barbara is intrigued by books, and she will undoubtedly enjoy reading aloud as her skills increase. I will arrange opportunities for her to do this with older children, and sometimes with me. In addition, she will probably read to herself. By spot-checking her reading, I will be able to see how her fluency and vocabulary are progressing and whether the books she selects herself are too hard or too easy. (Beginning readers are likely to choose books on their own level, so this seldom seems to happen.)

Barbara has enjoyed dictating her own stories and should soon be able to begin writing her own simple stories. She can keep a list of the words that she needs to ask for and review them to add to her sight vocabulary. Eventually she can make her own "dictionary" of words she needs and use it to refer to in writing her stories. I expect she will like to read her stories aloud to other children during our discussion times.

Barbara can also be encouraged to extend her records of other work done in the classroom from pictorial or dictated information to include some writing on her own. Persistent and not dismayed by difficulties, she should

make fine progress in this area, which will contribute, in turn, to her reading skills.

Math Checks

1. One-to-one correspondence and conservation of number. Barbara made a second pile the same number as mine (12) by matching. No counting. When I moved the pile around, she said it was still the same. When I put the piles out of sight in boxes, she knew they were still the same.

When we played "store" and traded coins for objects, she knew we each had the same amount. Next time I traded six of my nine coins and asked her how many I had left in my hand. "Five." "How many did I start with?" "Nine, so you should have four left because I counted." After trading nine coins for nine objects, she knew she could buy back the objects "because one coin bought one thing at a time."

In the last check, she matched pile B to my pile (A) side by side. Next, she matched pile B to pile C in the same way. When I asked if pile A and pile C contained the same or different amounts, she said, "Yes, I think they are the same because you never took anything away from them after I fixed them." She then checked this by matching.

Barbara never counted during any of the above. However, when I asked how many there were in pile A, she counted quickly and accurately.

2. More than, less than. Barbara had no difficulty with this, telling me that three more than four was seven, and two less than 10 was eight.

3. Seriation. Barbara started to order the strings of differing lengths by using a baseline. She took them one at a time, matching the length from shortest to longest. About halfway through she got mixed up and started a second time. This time she didn't use a baseline but did order the strings correctly. She had one left over, which she fitted in hastily and incorrectly.

4. Conservation of continuous quantities. We started with two identical glasses of water. Barbara poured hers into a low, wide jar and told me, "We have the same amount, but yours is taller and mine is fatter." She poured it back into the glass, then poured it out again into three small glasses. "We still have the same amount, but mine is in separate things."

5. Classification and class inclusion. Barbara had no difficulty with the terms "same" and "all" in the check using pattern pieces.

In the check using cards of four boys and three girls, she sorted all the boys together, then all the girls, and told me, "There are more children (than boys) because there's seven children and four boys, I arranged them like a sculpture."

The next check involved nine orange and three blue wooden beads. Barbara was not able to apply the idea of class inclusion here, and so she thought there were more orange beads than wooden beads.

6. Parquetry cards and tangram cards. Barbara showed a good grasp of the spatial relationships involved. She worked quickly and with concentration, systematically fitting the pieces to the designs.

She also worked well fitting the tangram pieces to the design cards. She said, as she did this, "Two of the same shape; no, I need a bigger one." On card 6 she kept getting close to a solution, but didn't see what to do. Finally she said, "Maybe if I turn the card around I can do it." And she did. She then worked quickly through card 8.

7. Math balance. Barbara was successful in the first two checks using the math balance. She quickly matched one weight on her side to the one on mine, then next placed one weight to balance my two weights.

On the third check she resorted to trial and error to balance my one weight with two on her side. However, she solved this fairly quickly. I asked her to do it again; this time, she couldn't hold on to the idea of how to move and so resorted to random placing of weights.

Evaluation and Suggestions for Learning Strategies Based on the Math Checks

Barbara seemed to be in the stage of concrete operations in almost all the checks. She was the youngest child to do the math checks, which indicates that other factors besides age are involved in the development of concepts.

In the activities used to check one-to-one correspondence and conservation of number, Barbara solved all the problems by matching. She felt no need to count to corroborate the sameness of the amounts. However, when I asked her to count, she did so quickly and easily. She also did well with problems involving "more than" and "less than." She appeared to have a firm notion of conservation of number in all the tasks.

Barbara also showed a good understanding of ordering in arranging the strings. She had the idea of a baseline, and though she didn't follow through on this she displayed a grasp of the problem. Her inaccuracy in placing the leftover string seemed mainly due to haste, since she had placed the others systematically. (It would have been a good idea to check this by having her add an additional string.)

Barbara was one of the two children who grasped the concept of conservation of continuous quantities. She was firm about the amounts remaining the same, regardless of the containers, and was able to give good reasons: "Yours is taller and mine is fatter." Thus, she balanced out the perceptual differences.

Barbara also had no difficulty with the concept of class inclusion in the experiment involving cards of boys and girls. She knew there were more children than boys, and again offered an explanation: "There's seven children and four boys."

The check involving wooden beads was more difficult, and Barbara was unable to apply the concept of class inclusion here.

Barbara did well with the design cards. She worked in a systematic way,

and when she got stuck she had the ingenuity to turn the card around for a new approach. She displayed a good sense of spatial relationships in her approach.

Barbara solved the first two problems on the math balance quickly. She knew which direction to move in to make the beam balance. On the last check, she became confused and lost the idea of how to move.

All these checks reveal a developing ability to think logically and to solve problems involving relationships. Barbara seems ready to use structured materials appropriate for children in the stage of concrete operations. She still needs to manipulate materials freely and have time to experiment, but activities such as chip-trading in various bases, the 10's game, and other math games will challenge her. Once she has learned how to play these, she can use them on her own. I would also like to start her using Cuisenaire rods, first in simple sorting and matching activities, next with movable number values, to express number relationships. Barbara could also work on activities using pattern blocks and attribute blocks. Measuring projects would be appropriate, starting with her own units of measurement and moving to standard measures later on.

When Barbara becomes interested in recording, she can write her answers in simple sentences or pictures. Next, she can begin to use symbols such as the signs for "greater than" and "less than" or arrows suggesting operations. As the need arises, she can learn the signs for addition and subtraction. However, I think this should be preceded by a great deal of practical math and oral computation, such as occur in daily classroom activities and games.

One Year Later

The reading and math checks were accurate predictors of Barbara's development this year. She has made large strides in all areas, working largely on her own. Her curiosity and persistence have led her to explore many materials and activities in surprising depth, and she has been interested in following through on new angles when I have suggested extensions of her work. One example is her plant study. Barbara planted and tended her seed, wrote a daily journal describing its growth, with accurate pictures, wrote a story about it, and then (at my suggestion) made a graph of the measurements she had voluntarily recorded over the past month.

Barbara's reading skill jumped ahead during the summer, apparently all through her own efforts, for she returned to school reading beginner books with ease. I practiced handwriting with her, reviewing the work we had done the previous spring and showing her all the other lower-case letters. She picked this up quickly. I went over short-vowel words with her, through dictation, so that she would blend and write them by herself. I then rapidly introduced consonant blends, a few vowel combinations, and some basic sight words to her. Barbara incorporated these immediately into story-writing, one of her favorite activities. I made her a personal dictionary with blank pages so that she could ask for words when she needed them. At various intervals, when she seemed ready, I showed her new spelling patterns, such as

silent-e words, which she then integrated into her writing. Much of Barbara's writing is phonetic; her acquisition of sight words can't keep up with her enthusiasm for writing ("thingk," "nite," and "wawk" being recent examples). Barbara also continues to read, moving on to more and more difficult books. Note from December: "Barbara reads to herself often for her own enjoyment. She also likes to read aloud to her friends. Her writing is fluent and imaginative."

Barbara has also been interested in using a variety of math materials. She has learned the chip-trading game (she is able to do direct trading in groups) and likes to play it. She has often used the sand and water trays, measuring with various utensils. She has played the "10's game" and other games that involve computation with competence. She has recorded her work with the pan balance and has done several measuring projects. Barbara has especially liked using the Cuisenaire rods and, after becoming familiar with them through games, began to use symbols as a shortcut for recording her patterns. Since she seemed quite clear about the use of symbols, I showed her "missing number" problems in addition and subtraction, using the rods. She now writes problems for herself and enjoys solving them with rods.

I checked Barbara in March on various conservation tasks. She was operational in the class-inclusion check involving wooden beads, in conservation of length, and in conservation of continuous quantities, and was transitional in conservation of area.

My challenge with Barbara is to provide enough fresh classroom stimuli to engage her curiosity, to suggest projects that will trigger her interest, and to help her with skills at appropriate times.

BILL
(5 years, 10 months)

Reading Predictions Based on Classroom Observations

Bill has spent most of his energies this year watching what older boys are doing and trying to copy them. He is capable of working hard and concentrating well at a task, but he won't get involved unless he sees older boys doing it first. He is generally tense and very shy and quiet. He has a very limited vocabulary, seldom talks, and never uses full sentences. He also speaks with a lisp, which may have something to do with his slow progress in learning letter sounds.

He now knows many consonant sounds and may know more than I think he does, because when he is unsure of one he won't venture an answer, even in a game situation. When asked to identify beginning sounds in a word, he sometimes gives end sounds. He is also unable to discriminate sounds in the middle of words (such as the a in "man"). He can rhyme, however. He also tries hard to learn the words to songs, but it isn't easy for him. In rhythmic clapping, he concentrates hard but only does fairly well.

Bill likes building and shows good spatial sense, not only in his constructions, but also in various parquetry and tangram designs. However, he presently has some directional problems (which I suspect are due to immaturity, not more complex factors). For example, when asked to make a circle in a given direction, he was totally unable to do so.

Bill is physically well-developed, but his small-muscle control is immature for a child his age. He holds scissors clumsily and cuts with difficulty. His drawings are extremely primitive, and he has only recently begun to hold a pencil properly.

Bill's visual discrimination seems normal (he can match similar symbols, most times, and can distinguish a number of letters), but again, because of his shyness, I'm not sure to quite what extent.

I expect that Bill will need some extra time in the fall for readiness activities, though he may be one of those children who do a lot of growing up during the summer. My hunch would be not to rush him, but to plan a variety of prereading activities that will provide good groundwork. I think he is probably highly motivated and quite determined, so that when he is ready he will make good progress. However, because he is shy and tense, I think it would be a crucial mistake to push him before he is thoroughly--perhaps even more than--ready.

Diagnosis and Recommended Learning Strategies Based on the Reading Checks

Several elements of Bill's oral language need help: his oral-language level (telling a story) is low, and in category names and sentence memory he is very poor. This ties in with Bill's classroom behavior: he seldom speaks, even with other children, and when he does he exhibits a very limited vocabulary and sentence structure, that is, he speaks in fragments, and only when really necessary to convey an idea. Bill's inability to express himself verbally is constricting. When he is angry, for example, he holds it all in until he bursts and then has to express it in sometimes violent and uncontrolled physical action. This has improved during the year, as has his willingness to try to talk to me and the children.

Bill also did poorly on blending, which appears to be primarily an auditory skill. However, since it involves saying the blend, and because speaking is a difficulty for Bill, I would tend to include this as a language disability, not necessarily an auditory one. This is borne out by the fact that Bill did very well on the sound-discrimination test, a distinctly auditory task, where the only response necessary was "yes," "no," or even a nod or shake of the head.

Bill had trouble with two of the checks for visual discrimination. He did well in word-matching, but not on the nonsense-word-matching, which appear to me to be very similar. However, if one looks at the numerical scores, Bill was within one point of a rating of "good" on the nonsense-word-matching, and so I would be inclined to give him more credit on this item.

Although Bill did not rate well on many of the checks, this is balanced,

in my opinion, by his persistence and motivation. He listens and follows directions well, works with concentration and persistence at tasks that interest him (and even those that are teacher-directed and perhaps uncongenial), and, for a five-year-old, can sustain independent work well. Given these qualities, I think Bill will compensate for his other difficulties. He also seems immature in some ways: even though he has learned to control a pencil reasonably well, his drawings are those of a younger child. He prefers large-muscle activities, such as block-building and constructions, to detailed work, and needs time for a great deal of active play.

So in our plan for Bill next fall, active play should have a large part because of the language implications (since oral language is his weakest area). In forgetting himself in play with others, Bill will be more likely to talk freely and develop his vocabulary and ease of expression. Bill can also be encouraged to take part in dramatic play as an additional avenue to self-expression. For a child like Bill, chances in the open classroom for continual conversation and interaction seem particularly important, together with the teacher's emphasis on explanations: "What are you building?" "How fast do you think the marble will roll down the ramp?" "What did you notice that was different about your plant today?"

Bill can also be encouraged to do more picture stories--drawing pictures in a book specially made for him and dictating something about the pictures. At first this will probably be factual--"This is a boat"--which I or an older child write in his book for him, and which he can try to read back if he wishes. With greater confidence and practice, Bill can later be urged to add details of color, action, perhaps even a story to be read to the entire class at discussion or sharing times, if he is willing, either by him or by me. Since Bill has seen other children do this, he may come to enjoy this kind of group participation, which can be had with no frightening need to "talk" on his part.

Certain games will foster Bill's language development: cardgames (such as lotto) that involve asking for cards, pattern-block activities, and so on. Some can be played easily with other children. Others, like the pattern-block game, which extends the child's vocabulary of shapes and spatial relationships ("Place the yellow hexagon behind the red triangle") are best played with the teacher participating too. Phonics games, such as vowel lotto and consonant lotto, would also be useful, not only for their reading implications, but also for practice in articulation.

Since the reading checks do not point out any of Bill's particular strengths, I think his reading activities should cover a wide range as we continue to look for particular areas of success. Considering Bill's determination and interest in learning to read, he seems ready for a few structured activities. (I would expect him to continue to pick up connections between the letters and their sounds, that is, consonant and short-vowel sounds, through the phonics games. Bill already knows his alphabet and most consonant sounds.) These activities can center, at the beginning, around carefully taught handwriting in a small group three or four times a week. We might begin with the formation of lower-case letters, together with their sounds. With Bill, it might be good to use a workbook that connects visual clues with

saying sounds and offers directional arrows for help in forming letters. (I am a strong believer in having children form letters correctly from the start, if possible, to avoid reversal problems and bad habits. This can only be done with lower-case letters for most children, since most parents have already taught capital letters.) If Bill enjoys this and does well, we can go on to writing combinations of letters and blending them. Even though Bill did badly on the blending test, I want to work on this with him, because the only two words out of ten he did correctly were the two most difficult, the ones that split words into three parts: "c-a-t," and "b-i-g." I also plan to introduce simple sight words such as "was," "on," "the," and go on to others if Bill shows ability in this direction.

I hesitate to go any farther in a plan for Bill. My hunch is that he shouldn't be hurried and that his own timetable and pace may differ from what I anticipate. I would prefer to work along comfortably with him, seeing what strengths develop, and to take my timing from him. This will mean frequent reassessments during the fall period.

Math Checks

1. One-to-one correspondence and conservation of number. I gave Bill a pile of stones and asked him to make a pile of stones having the same number as a second pile of 12 cubes. First he counted randomly, counting one stone twice; on the second counting he was accurate. Next I asked, "Is there another way to know the piles are the same without counting?" He quickly placed each stone on top of each cube.

Next I got out nine coins and a group of miscellaneous small objects for a "store." With him as storekeeper, I bought nine things, exchanging one coin for one object each time. I then removed the extra objects and asked, "Do you have as many coins as I have objects?" He had to line them up to answer. Then I took the nine coins (which we counted again) and bought six objects, and asked, "How many coins do you think I have left?" "Six coins." "I mean in my hand?" "Six." "How many did we start with?" "Nine." "So in my hand?" "Seven." "With all the money you have, can you buy all the objects I have?" (we had finished buying the remaining three); "Yes--'cause first you bought all the things I had."

With three sets of objects Bill equated A with B, then B with C. "This (A) is the same as this (C) because this (A) is the same as this (B), and this (B) is the same as this (C)."

I did the trading of coins for objects again with Bill the next day, using a different set of objects, and he had no trouble telling me I had three left in my hand: "You have three in your hand because I have six here."

2. More than, less than. Bill did well with this check, using numbers up to 10.

3. Seriation. Bill found it hard to get started on the idea of arranging strings (I avoided saying "according to size"), so I got out nesting cups to suggest the idea. He arranged them randomly: "I made a line." I finally suggested that he arrange them according to size. He did this. Next he took the strings and ordered these, without using a baseline. He placed each one

by trial and error, sometimes taking two or three tries. He thought some were the same length, even after measuring. Finally he finished, saying, "They're in a line, from little pieces first, then a bigger, then a bigger."

4. Conservation of continuous quantities. We started with two identical glasses filled with water--one for Bill, one for me. Bill verified that the amounts were the same, then poured his water into a wide jar. "We have the same amount because first they were the same and I poured all of mine in here." He poured it back into the glass, then poured his water out into three small glasses. "We still have the same." Bill was confident in his answers, with no wavering in his understanding.

5. Classification and class inclusion. Bill did well on the check involving the terms "some" and "all." He sorted the red and blue squares and red circles by shape, and he had no trouble with such a question as "Are some of the squares blue or are all of them blue?" In the check using cards of three nearly identical girls and four nearly identical boys (as close as I could make them), Bill sorted silently. In response to "Are there more children or more boys?" he answered, "More boys." "Aren't the boys children?" "Yes, there are more children. But some are grownups." "Well, let's pretend they're all children." He counted again and rearranged the cards, with two boys as grownups. "There are more children because there are two grownups."

In the experiment involving wooden beads, Bill sorted out the nine orange beads and three blue beads and told me they were all made out of wood. When I asked, "Are there more wooden beads or more orange beads?" he thought there were more orange.

6. Parquetry cards and tangram cards. Bill constructed his parquetry designs carefully, with a good idea of spatial relationships. He worked for a long time. He seemed to be able to visualize where the pieces should go. Bill was the only child checked who made the three-dimensional cube designs standing up, in perspective. He was quite accurate in his constructions.

Bill worked quickly and confidently fitting the tangram pieces to the design cards. He did the first eight cards, then returned voluntarily to complete numbers 9 and 10. He was the only child to complete more than eight.

7. Math balance. I did three successively more difficult tasks, using the math balance.

Bill did well on the first one, which involved placing one weight on his side to balance the weight on my side.

On the next check, I placed two weights on my side. He balanced this with one weight through considered trial and error, that is, he began at 1 and moved in the correct direction until it balanced.

The third check involved matching my single weight with two weights, Bill was unable to do this, although he started out by moving in the correct direction.

Evaluation and Suggestions for Learning Strategies Based on the Math Checks

Bill appears to be in a transitional stage in many of the checks--on the

verge of achieving operational concepts, but still using intuition and relying on perception in many areas.

In counting activities, Bill has the idea of matching to find out whether he has the same amounts, but is unable to hold on to the idea of one-to-one correspondence, and after trading on a one-to-one basis he has to line the objects up to see if the amounts are equal.

However, on a second trading he knows that we have the same amount, "'Cause first you bought all the things I had." This inconsistency is a mark of the transitional stage; concepts are not firm, so can be used only in some situations and not others.

Bill can do problems involving "more than" and "less than." He used stones to work out his answers, and did these problems with accuracy and enjoyment.

Bill had a difficult time getting the idea of ordering the strings. I'm not sure whether this was because he was afraid to be wrong or because of trouble in communicating. When he got started, he ordered by trial and error, "Little pieces first, then a bigger, then a bigger."

I was surprised that Bill understood conservation of continuous quantities. He was perfectly confident in his answers and could give reasons for them. Perhaps this is because he spent a lot of time last year at the sand and water tables, busily pouring from one container to another, or making sand molds (a fine illustration of conservation of volume). This seems a good example of how using materials can help a child form a concept.

The next check, which involved a more abstract approach, was classifying the cards of boys and girls. Bill thought there were more boys than children. When I said they were all children, he shifted his classification to encompass this. He called two of the cards grownups and said the rest were children, so that there were more children. I asked him to pretend that all the cards were children, but he was unable to change his classification or his point of view. (This inflexibility calls to mind a preoperational stage.) Bill was also unable to use the concept of class inclusion in the check involving wooden beads.

Bill did unusually well using the parquetry designs and pieces. He worked with concentration and showed an awareness of spatial relationships. Once again, as the only child able to make the three-dimensional cube designs in perspective, Bill also completed more tangram cards than the other children who were checked.

Bill worked successfully with the math-balance problems. He understood the correct direction to move in to achieve a balance and used this concept systematically. He could not solve the last problem (a single weight versus two weights) but he did continue to move in the right direction. Addition did not enter into Bill's procedure; it was based on his understanding of how balance beams work, which may stem from his interest in making constructions with movable parts.

These strengths of Bill's will make a good basis for his math work next fall. He can continue using tangram cards and will probably enjoy activities with pattern blocks. With his interest in building he might also like measuring projects, first using his own units of measurement and, later, standard measures. Carpentry might also be a fine activity for Bill. Problems to be solved at the sand and water tables, such as how many cups will fit into a quart container, can also be used.

At the same time, Bill apparently needs more experience in one-to-one correspondence. This can be worked into daily activities in a spontaneous way by asking questions involving counting and comparisons with such structural materials as Unifix cubes. Bill should also be encouraged to join sorting activities, which are a constant part of classroom life. (Besides enticing "setups," there is always the jumble of mixed materials to be separated and counted.) Bill will also probably enjoy using other structural materials, such as the Cuisenaire rods. His introduction to rods might be matching, sorting, making "trains" of the same length, and so on, with no use of numbers until he is secure in his basic concepts.

One Year Later

Bill seemed at home when he returned to school this fall, and as his self-confidence increased so did his willingness to express himself.

Notes from November: "Took part in several puppet shows. Spoke in them! Lots of Lego and block construction, coupled with dramatic, verbal play. Taught a five-year-old a new game and explained it. Is using language increasingly, especially in play situations."

In my fall conference with Bill's parents, in response to their queries about Bill's reading, I explained that he needed more language development before he would be fully "ready" to read. Bill's father said that Bill is seldom able to finish a sentence at home: his older sister teases and interrupts, and his younger brother insists on getting attention. I suggested that the parents try to arrange times when one of them can be alone with Bill so that he can express himself without fear of interruption. Bill's father has done this, by doing such things as taking Bill off alone in the car to talk together.

Bill has shown decided strengths in his math activities this year. He has voluntarily chosen to use many math materials: the balances, the 10's game, Inch-by-Inch, Parcheesi, sand pendulum, and measuring activities. I did lots of matching and category games with Bill in addition to his own explorations. He particularly liked using Cuisenaire rods--sorting, making trains, matching lengths. When he became interested this spring in using units to measure rod lengths and recording his answers, I introduced symbols for "greater than," "less than," and "adding on." Bill is very clear about the meaning and use of these signs and uses them independently.

Since I decided to corroborate my observation that Bill's concepts had become operational, I checked him again in March on inclusion. He had no

trouble with the boys-children check. He was also able to maintain that there were more wooden beads than orange beads. Bill was also operational in checks for ordering, conservation of continuous quantities, length, and area. He solved all math-balance problems quickly and accurately. He had already whipped through the entire first set of tangram cards and was working on the second set on his own. Bill is the only child in the study group who is operational in all these areas now.

Even though Bill has been able to forge ahead on his own in math areas, he needs careful, consistent help with reading skills. This is not due to lack of interest, for, as the diagnostic checks showed, Bill is persistent and motivated. Since these checks did not point out any particular strengths, except for sound discrimination, I have approached readiness activities from several angles (aside from the main one of language development). Bill has worked in a workbook, practicing handwriting and sound-symbol associations. He has enjoyed this. I have also used many phonic lotto games with Bill. Although he can discriminate differences in sounds, he has difficulty articulating them and needs lots of practice. As Bill becomes more confident at these games, I have suggested that other children join us, and Bill has been able to take turns asking for the cards and sounds he wants.

In the afternoons, beginning in November, I worked alone with Bill introducing rhyming words for short periods. Bill couldn't blend them, but he could see the similarities and repeat them. Meanwhile, Bill became very interested in dictating and illustrating picture stories. I made cards for key words in his stories, which he was able to recognize by configuration (a tie-in with his good sense of spatial relationships). Bill then read his picture stories aloud to the assembled group at discussion time and felt very pleased to be able to do this. (This was short-term memory, for he didn't retain the sight words long.)

In December, Bill began to make connections in blending. To simplify this process as much as possible, I printed two-letter blends, such as sa, fa, and asked him to add an ending consonant, such as t. We worked regularly at this for about ten minutes nearly every day.

After Christmas, Bill seemed ready to join a small group working on phonics three times a week. He became more adept at blending and started to write sentences from dictation, using all the short-vowel sounds as well as some sight words ("the," "of," "is," etc.). Reading back his sentences continues to be more difficult for Bill than writing, so we are trying to give him extra time reading aloud very simple phonic readers to one other person.

I feel the study of Bill has special implications for a teacher in an open classroom. It is not enough to present such a child with interesting challenges; one must also be aware of his strengths, weaknesses, and level of readiness. Whereas Bill's strengths in discovering mathematical relationships enabled him to do a great deal of independent work, aided only by suggestions or the occasional teaching of new approaches, his language difficulties made it especially important for me to train and reinforce his beginning skills in reading as he became ready for each new step.

JOHN
(5 years, 11 months)

Reading Predictions Based on Classroom Observations

John has an excellent speaking vocabulary. He is an early reader, using mostly the sight method and picking out and remembering words well. However, he also knows all his sounds and can isolate sounds in the middle of words. John is highly motivated to read: father and mother encourage this at home and place a high priority on it as well as on his intellectual skills.

John can concentrate for long periods of time on a task if it interests him, if he feels he is doing it successfully, or if it gives him class status (as in Monopoly).

John has unusually poor manual dexterity and physical development (slight, underdeveloped muscularly); he has poor control of his voice (talks too loudly, has difficulty regulating voice dynamics); drools when speaking. Eating lunch, for example, is a singularly messy business (spoon to mouth is especially hard). Also, his spatial sense is poor, as shown in fitting blocks back into a box. John appears to have directional problems; when asked to make a circle like one I drew on the blackboard, he made a circle but started at the bottom and went in the opposite direction. When I repeated mine, he still couldn't do it. John has worked this spring on "directional mazes" to help develop his ability and awareness of directions. John's pictures are those of a much younger child, almost scribbles. But he will dictate complex bits of information about them.

He has used the sand table a lot; I suspect a need for using materials, which were not a part of his preschool life. He doesn't like to get his hands dirty, and won't use paint or clay unless encouraged. He is very dependent on adults for direction, praise, and ideas. Also, he tires easily. He will work on something, like one piece of a mobile, then go lie down.

Socially, John is timid and anxious and finds it difficult to get along easily with the other children.

When we have music, John has a hard time with clapping rhythms--he just doesn't get them. He also has a lot of difficulty memorizing the words. I wonder whether this is because it's an unfamiliar skill, or because the auditory memory involved in songs uses a different part of the brain than that involved in words and information, and whether this is connected with his physical immaturity.

I expect that next year John will increase greatly in his reading skills, without any teaching, just through his interest and quick sight memory. However, I think that learning to write will be difficult, for purely physical reasons, and that emphasis should be on finding and planning activities to develop his motor control.

I am concerned that his reading will so far outstrip his writing that he

may block in writing. Thought should be given on how to make him feel positive about this even though it does develop slowly.

Query: Is John's poor motor coordination due to immaturity, lack of practice, some kind of brain dysfunction, or perhaps a combination? How important is it to know which one, in devising a learning program?

Diagnosis and Recommended Learning Strategies Based on the Reading Checks

John exhibited strengths in all the oral-language areas of the checks. Checks relying on visual and auditory skills were also strong, with one exception--tapped patterns. Considering the difficulty John has with visuomotor tasks, I am inclined to attribute his low score on tapped patterns to the motor control involved, not to lack of auditory discrimination. In fact, at the time of the check, John commented on the loud and soft qualities, but was totally unable to reproduce them.

I would also be inclined to rank John lower on the Bender Motor Gestalt than the scoring directions strictly allow me to do because his designs exhibited spatial problems, running into one another and figures not totally closed or connected. John's execution of the Bender Motor Gestalt designs was revealing. He held the pencil in toward himself and looked at the card while he drew, not at his own paper. He talked constantly while drawing--counting the dots, discussing the shapes. Spatial and motor problems were also pointed up by the way John circled nonsense words, for example, missing half a word in his attempt. John uses a pencil with considerable difficulty, holding it awkwardly and controlling it poorly. Coordination problems are evidenced in other areas not included in the checks: John is clumsy, bumps into things, has trouble running and skipping, and cannot control the volume of his speaking voice.

John compensates for these disabilities by being extremely verbal. He has a good vocabulary, good sentence memory, and good sound discrimination. His pattern memory is also excellent in both visual and auditory areas.

The second part of the checks--additional observations--pointed up some interesting sidelights. John is only a fair listener and is poor at following directions, the latter partly due to his penchant for reinterpreting and thus changing directions. His persistence is also poor, due, I think to his low tolerance of failure. If things get hard, he is quick to drop them. However, John is highly motivated to read and has been busily picking up sight clues all year. After dictating a "picture story," he is usually able to read it all back. He has also learned to read room signs and beginning books almost entirely on his own.

It is apparent that John will be an early, successful reader. This definite strength should probably be encouraged more than I have done in the past, mostly due to my concern that John's reading would so outstrip his writing that he would begin to block on writing. However, it should be possible to build up his self-image through reading success while being supportive

in the more arduous and discouraging (for him) task of learning to write.

Strategies for the fall should include the following learning situations (no writing involved): recognizing word families and their similarities and differences; new sight words (John's own box of sight words on separate cards might be fun for him, to add to daily); reading aloud from progressively harder books, with new or difficult words written out by me for the sight-card box; and dictating his own stories and reading them back to the class.

I feel that motor training should not be neglected. John should continue to have plenty of time for active play, using big blocks, construction materials, and sand and water, which will help him learn to interact more fully with other children. John enjoys dramatic play, and this can also be encouraged.

Since John demonstrates spelling strengths, once he has learned to form his letters he should be able to go directly on to more sophisticated writing activities. I expect, however, that he will need many weeks of careful teaching to learn his lower-case letters. John might benefit by working on this skill in a small group, with Bill and perhaps Dave, which would give him the social interaction and learning to listen and follow directions in a group that he needs. John should also have constant opportunities to work with materials involving small-muscle skills. Paints, crayons, scissors, and clay are splendid developers of precision and are unthreatening mediums. Small-construction sets, like Lego, parquetry designs, color cubes, puzzles, and tangrams could also be used. Woodworking in the shop, cooking, and sewing are all part of the classroom life, and John could be included more often than usual in all these activities, particularly when a teacher was there to give help and instruction.

The queries I put forth in the classroom observations written in April, before the checks, have still not been answered: Is John's poor motor coordination due to immaturity, lack of practice, some kind of brain dysfunction, or perhaps a combination? How important is it to know which one, in devising a learning program? I am inclined to think that it is a combination of all the above, with major emphasis on motor immaturity, for John's motor development is unusually slow. However, since he is clumsier than many one-year-olds, who can pick up tiny objects with precision, it is hard to avoid the conclusion that messages from the brain to controlling nerves and muscles are imprecise. Lack of practice is to be expected; difficult activities tend to be avoided by most people, and John talks where most children act.

As for the importance of this information for teaching (to the best of my knowledge after reading on this subject), I am suggesting the same careful, consistent, even repetitious teaching plus manipulation of materials for John that is advised for children with minimal brain damage in connection with learning to write.

Math Checks

1. One-to-one correspondence and conservation of number. John correctly

counted out 12 objects to match my original pile of 12. He knew the numbers remained constant when I rearranged the piles or spread them out. However, he couldn't think of any way to equate the piles without counting.

When we played "store," trading nine objects for nine coins on a one-to-one basis, John was unable to tell if the piles were the same. "I'll have to count." The next time we played "store," again starting with nine objects and nine coins, which John had verified by counting, I stopped after trading six times and asked, "How many coins do you think I have left in my hand?" "Six, because I counted the coins on the table" (already traded). When I reminded him we'd started with nine, he tried again and guessed "Five." When we finished trading, he thought we had the same number, but couldn't give any reason.

In the next check, which involved matching three sets of objects, A to B, then B to C, then asking whether A and C had the same amount, John had considerable difficulty. First he miscounted pile A (random counting--he counted one object twice; on the second try he counted out 12 objects). Next, he had a terrible time getting pile B to equal pile A. (I think he may have thought I was asking him to do something more difficult than I was.) First he counted out nine objects in pile B, then counted some more in pile A. I corrected this, and he started again and counted up to nine. He found this wasn't enough, so he piled on eight more objects. I asked him, "Which pile has more?" He counted both, then said, "This pile (A) has more because it has 12." "How many does the other pile have?" "Seventeen." "The first pile (A) has more." He next added to pile B to equate it with A. He did a lot of random counting. Finally he started taking away from pile B until he got it down to 12. It took a long time. He then made another pile, C (stones), to equal pile B (miscellaneous objects, which were clearly harder to count). When asked if piles A and C were the same, he said, "I think this pile (A) has two more, because I'm looking at it closely and I think it has."

2. More than, less than. John understands and can use these terms in connection with small numbers. That is, he can tell you that two more than four is six, or three less than 10 is seven. He does this in his head.

3. Seriation. When John was asked to arrange cutouts of feet, he put them in order from longest to shortest. However, he was unable to give a reason for this.

In arranging 10 pieces of string, cut to varying lengths, John ordered them "like steps," but didn't use a baseline.

4. Conservation of continuous quantities. John lacked the concept of conservation of continuous quantities. When I poured the water from his glass into a wider container he thought the amount had changed and become less. When I gave each of us equal amounts in glasses, then poured his into three smaller glasses, he said, "I've got more now. No, you've got more. I'm going to make a wild, wild guess. Maybe we both have the same!" However, when I poured his back into the original glass and he accepted the fact that now we both had the same amount, no light dawned as to the constant quantity of the liquid.

5. Classification and class inclusion. In the check involving an understanding of the terms "some" and "all," John did well. He sorted the red and blue squares and red circles. He had no trouble with such questions as "Are

some of the squares blue or are all of them blue?"

The next check involved sorting a group of cards picturing boys and girls. John sorted these alternately and had no difficulty with the question "Are there more boys or more children?" "Children, because they're boys and girls, four boys and three girls, and they're all children."

The third check involved nine orange and three blue wooden beads. After sorting and establishing the fact that all the beads were wooden, John was asked, "Are there more wooden or more orange beads?" He was convinced that there were more orange ones.

6. Parquetry cards and tangram cards. John had a hard time making the parquetry pieces fit the design cards. He went over the edges, fitted the pieces badly, and gave up. Using the three-dimensional cube designs, John ignored spatial relationships and built the designs flat on the table.

John worked hard on the tangram cards and succeeded in doing the first eight designs. He needed some help, for he had trouble matching things like the right-size triangular piece to the outline of it.

7. Math balance. I did three successively more difficult tasks, using the math balance.

In the first one, I put one weight on my side and asked John to balance by adding one weight on his side. He did this easily.

Next I put two weights on my side, and he was able to balance these with one on his side.

The third time, I put one weight on my side and asked John to balance it with two weights on his. This was considerably more difficult, and he resorted to totally random trial and error, for he couldn't hold the concept of moving in the right direction to balance the beam.

Evaluation and Suggestions for Learning Strategies Based on the Math Checks

John lacks the concept of one-to-one correspondence. He seems to depend totally on counting, and even though he traded a small number of objects (nine) on a one-to-one basis, he was unable to tell whether the two piles contained the same number of objects.

John also had a great deal of difficulty counting, particularly when it involved making two piles having equal amounts. He counted some objects twice, or the spaces in between. After counting out three piles with the same number of objects, he was asked if the first and third piles contained the same number. His answer, a splendid example of preoperational thinking, was based on what he saw: "I think this pile has two more, because I'm looking at it closely, and I think it has."

John had no trouble with tasks involving the terms "more than" and "less than." He computed the answers in his head. He also did well with the first two math-balance problems, relying on computation to solve them and placing the weights directly on the correct numbers. This, coupled with his lack of understanding of conservation of number, seems a contradiction to me. In class, John enjoys counting--mostly in his head--and figuring out number

combinations. He can also play Monopoly, which requires counting money. (He was taught to play this by his father. There is considerable emphasis on the intellectual approach at home, with almost no use of materials.)

Perhaps lack of experience in manipulating materials, combined with John's spatial and directional problems (the design cards point this up) and his difficulty with small-muscle control, result in random counting and an unawareness of the constant properties of numbers.

John ordered the strings according to size, but he didn't use a base-line and was unable to give a reason for his arrangement.

John did not have the concept of conservation of continuous quantities; perceptual factors were too powerful. However, his comment, after shifting back and forth from "I've got more now. No, you've got more. I'm going to make a wild, wild guess. Maybe we both have the same!" indicates that there is a glimmer of awareness forming. This places John in an intuitive, or transitional, stage of this concept.

John was able to apply the concept of class inclusion to the experiment using cards of boys and girls: "They're boys and girls, four boys and three girls, and they're all children." This is operational, including certainty and the ability to give a reason.

The check involving wooden beads was too difficult, just as it was for all the other five-year-olds I checked.

The design cards were hard for John. He went over the margins, chose pieces poorly, and gave up entirely on the parquetry designs. He worked hard at the tangram cards but had spatial problems, such as selecting the correct-size piece to fit into its outline. I am not clear whether his spatial sense will improve with practice, thus making it appropriate to encourage the use of such materials, or whether he has a far-reaching lack and this area of weakness should be avoided. In the fall we can feel our way on this, not pushing such activities, but encouraging John not to avoid them entirely.

I was surprised at the result of these math checks (except for the design cards). I had expected John to do very well with the conservation and counting tasks. I had been convinced by his enjoyment of counting that he understood the invariance of number. Now I realize that he needs lots of practice to fill in the gaps, using matching activities, trading activities, counting games involving one-to-one correspondence, and so on. I think that John, with his almost total avoidance of the use of materials, plus his highly verbal approach, might be one of those children who do well with written math up to a certain point, then begin stumbling over the lack of a sound foundation.

Learning strategies for John should include practical applications of math. Measuring activities, carpentry, cooking, counting milk cups to match the number of children present, doing attendance (which means counting tags and matching children), and other daily tasks might help overcome his reluctance to use materials. Math activities involving clay would also be good, not only for the messing around with his hands, but for feeling weight, mass,

density, for building tall and short things, fat and thin. John needs the doing, not the talking about his ideas.

One Year Later

John's voluntary choice of activities this year has fitted in particularly well with his needs and with the plans I had in mind for him. Notes from October: "Spends a lot of time building with Lego and acting out being an airplane, car, etc., actively with other boys. Checkers with Mark. Water play. Lots of drawing and clay. Has started carpentry, but refuses to cook. Seems much more independent this year."

Active use of materials throughout the fall began to improve John's immature motor control. At the same time, I worked with John on using materials to express his notions of number. He could tell me, quite confidently, that "8 + 7 = 15," but to illustrate this by arranging objects was a new concept, as if it hadn't occurred to him that number could be a property of things. John's difficulty with motor skills and spatial relationships made this a slow process, and he exhibited some initial anxiety about making mistakes. I also encouraged John to work with the pan balance and to join in various measuring activities, choosing his own unit of measurement. (John's grasp of conservation of length is transitional, so I felt that experimenting in this direction would help him cross over to a firmer concept.) Cuisenaire rods were among the materials I used regularly with John, chiefly in sorting, matching, and measuring games. It took John a long time to be able to match two shorter rods, end to end, with a longer one, and when we played games filling in missing lengths he had to make several tries to find the correct rod. John's visuo-motor integration steadily improved with these tasks, and his concepts of mathematical relationships also matured.

I checked John on his notions of conservation in March. He was clearly operational in the following: conservation of number, area, and continuous quantities. He used class inclusion in the check involving orange and blue beads. His manipulation of the math balance was quick and accurate. He only had trouble with ordering the strings, which he did awkwardly, and when I handed him two additional strings to insert in his arrangement, he had to start entirely over again.

Beginning early in the fall, I worked individually with John on building handwriting skills. Besides tracing letters and writing them in various combinations on lined paper, John used a workbook for handwriting practice with my constant supervision. His progress was slow but steady enough so that he could see an improvement in control. He started by being very anxious about making mistakes, but gained in confidence as he went along. He also became enthusiastic about dictating and illustrating stories and reading them to the class. Note from December: "John has copied his own text in picture stories a few times and has written a couple of stories sounding out (but mostly asking for) words. Often can spell them, but lacks confidence to go ahead. Needs lots of reinforcement."

In January, John began working in a small phonics group meeting three times a week, with emphasis on writing sentences from dictation and sounding

out the words. I think this has bolstered John's feeling of competence, because he has found that he can write capably, and while his letters are still shaky he can draw on his reading ability to check what he has written for correctness (a skill his friends have not yet attained). I have not done additional work with John on reading aloud, except to "spot check" him occasionally. He often reads to himself at quiet times and continues to gain a sight vocabulary, mostly on his own. His reading level is still considerably ahead of his writing, but he has gained such positive results from his writing improvement that I think we no longer need to worry about too much discrepancy between the two.

NIKKI
(5 years, 11 months)

Reading Predictions Based on Classroom Observations

Nikki needs special consideration, as she is a child who has had poor health, which has affected her development. She is physically small and delicate and appears to function as a young four-year-old. In spite of her condition, she is a cheerful, winsome little girl, warm and trusting.

Nikki expresses herself clearly, with quite a good vocabulary, and can tell imaginative stories. She also paints with an unusually nice feeling for color. But when we get into other areas, there are some puzzling contradictions: at times Nikki can understand and do a task, such as counting the dots on dice; at other times her confusion is total, as if the correct messages aren't getting through to her brain.

Nikki's muscle control, both large and small, is undeveloped. She is unable to make scissors cut. Her pencil drawings are usually scribbles. Likewise, her rhythmic sense is lacking; clapping rhythms is too complicated, and she sucks her thumb instead.

Nikki's auditory discrimination also seems weak, though we could perhaps work on this more than we have. She has been exposed to the same sound games as the other five-year-olds, but she has not yet begun to discriminate sounds with any regularity. She is not able to attach sounds to symbols or picture cards, either. Listening to stories, unless they are stories for very young children read especially to her, is too difficult. Nikki cannot follow the story thread or keep her attention on it. She also is unable to follow directions unless they are short and specific, containing one idea and given directly to her ("It is time to go to music"). Directions given to the group as a whole are not heard by Nikki.

Nikki is extremely dependent on adults and can only play the simplest games on a one-to-one basis. She spends a lot of time watching the other children, sometimes saying, "I want to do some work." However, her concentration is so limited and her skills so undeveloped that I really don't know how to work out a learning program for her. I suspect she has suffered some

brain damage that is preventing her from responding to stimuli as most children do. In the meantime, she appears to need lots of time for free play in the housekeeping corner and for manipulating materials such as clay, sand, and water. Drawing pictures, pasting, cutting, and other nursery school activities are still very difficult for her.

Visual discrimination is perhaps Nikki's weakest area. She took all year to learn to identify her name in print and is still unsure at times. She is unable to do parquetry designs except in a random manner, and certainly not following a given pattern. When she counts small objects, such as three colored one-inch cubes, she sometimes counts imaginary spaces in between, pointing with her fingers, and may arrive at seven cubes. Another time, she will see there are three.

Nikki's spatial and directional senses are also confused. Sometimes she will print her name correctly; other times backwards; still other times backwards and upside down. With the three or four letter-symbols she knows, she doesn't know which way is right side up.

I expect that learning to read and write is going to be exceptionally difficult for Nikki and that it is pointless to try until some basic concepts are learned and some confusions sorted out. How to do this will require more research on teaching strategies for children with learning disabilities.

Diagnosis and Recommended Learning Strategies Based on the Reading Checks

Nikki did well in most of the oral-language activities. Her picture-naming was good, and she told a coherent story. Her category names were fair, and so was her sentence memory. In all, it adds up to considerable ability in oral language.

Nikki did poorly in matching spoken or written configurations and also in the visuo-motor tasks. Her pattern-memory abilities were mixed, with poor results on the visual sections and good ones on the auditory.

I think it is important to note Nikki's strengths in two auditory abilities: blending and sound discrimination. Her sentence memory, also largely auditory, was comparable to what most of the other children did on this task.

Activities that lean heavily on visual abilities were difficult for Nikki. She did poorly on both word-matching and spelling, and only fairly on the nonsense-word-matching and word-recognition checks. I was struck by the difference in Nikki's ability to handle the two word-matching checks, which apparently require similar skills. Initially, she had lots of trouble finding and keeping her place in the nonsense-word-matching checks (where the words are in straight rows), but then she settled down and worked quietly and well. On word-matching, where the words are in boxes, Nikki got totally confused. The first day I tried it with her, she did the first box with help from me, but then continued to circle the same word in the next three boxes, in spite of my best efforts to explain. So I tried the check with her again a few

days later. She again did the first box with my help, but then was unable to find any word similarities in any of the other boxes. This may be significant, because I believe that Nikki has trouble with visual discrimination, particularly so if there is any irregularity in spacing or if items are not in rows. Her brain doesn't seem to receive correct messages in visual areas. This hypothesis should be checked out carefully in the fall because, if Nikki has this kind of disability, it isn't clear to me how she will be able to deal with the visual symbols of reading. Her difficulty with pattern-matching may be tied into the same problem, not one of inexperience, I feel, but one of possible brain misfunction.

The second part of the checks--additional observations--suggests a picture of a child who, in any case, has not reached "readiness" for reading activities. Nikki's ability to listen and follow directions is poor; she is unable to stay put at a game, but is continually on the move; she cannot work alone or be independent or persist in a task. This calls to mind the behavior of a much younger child and implies that Nikki needs more time to mature before she is ready for the kind of learning that requires continued concentration.

I feel that learning strategies for Nikki should first and foremost include free time for interaction and unstructured play with other children, giving her chances to practice developing her initiative, independence, and social skills. Since Nikki needs a great deal of adult support, this freedom should be interlaced with short games and activities with a teacher. These, considering Nikki's strengths in oral language and blending, might include sound-matching games ("Can you think of something that starts with the same sound that "mouse" does?"), oral rhyming games, and dictating stories, which she could illustrate. Nikki can also be helped to develop skills involving small-muscle control through painting, clay, sewing (large embroidery thread and needles on burlap would be suitable for her), collage, scissor cutouts, and so on.

Early in the fall I want to do further checking to see if I can find out whether there are certain patterns that are clear to Nikki and certain ones that are not. I plan to consult both the school psychologist and the reading specialist for help in further diagnosis and teaching strategies. I need to know if there is any consistency, for example, in the way Nikki perceives a row of beads or any other objects, as this has so much importance in relation to the printed page. In the meantime, before she makes any attempt to connect letter symbols with a sound, or word symbols with meaning, Nikki can be absorbing a rich background of auditory and oral relationships, which will be important to her reading success.

Considering Nikki's general immaturity, physical health, and lack of reading readiness, it seems reasonable to expect her to need an extra year before sustained work in reading is appropriate.

Math Checks

1. One-to-one correspondence and conservation of number. I started with

a pile of seven beans and asked Nikki to count them. She counted in a random way, saying numbers without relation to the beans she touched, and arrived at nine. Next, I asked her to make a pile to match my pile of five beans. She counted out five objects, then told me she had six. The next time she made a pile containing four objects to match my pile and told me it contained five.

2. More than, less than. When I asked Nikki (to ascertain her verbal comprehension), "If I have three beans and you give me two more, how many will I have?" she answered, "Three." When she counted she got four.

3. Seriation. Nikki took the strings of assorted lengths and laid them one after another in a continuous line. She couldn't think of another way of arranging them.

4. Conservation of continuous quantities. We started with two identical glasses of water. Nikki poured hers into a wide jar and told me, "You have more 'cause mine's in a flat dish." She poured her water back and agreed we had the same amount. Next, she poured hers out into three small glasses. "Now you have more because yours is in a bigger cup."

5. Classification and class inclusion. Nikki was clear about the terms "some" and "all." She told me that, out of a collection of red and blue squares and red circles, some of the squares were blue and all the circles were red.

In the check involving cards of four boys and three girls, Nikki put the boys together in a line, then continued with the girls. I asked her, "Are there more children or more boys?" "The boys are children. There are more boys."

In the check using nine orange and three blue wooden beads, Nikki was convinced there were more orange than wooden beads.

I did another check with Nikki, using cards showing five red tulips and five distinctly different flowers. I asked her to sort these into two groups. She was totally unable to do this. Her attention was on what looked nice together, and she made several groups, commenting on the colors and shifting them around and regrouping, but she could not place them in only two groups.

6. Parquetry cards and tangram cards. Nikki had no conception of how to fill the spaces. She confused the colors, went over the edges, and gave up. She could only do the very simplest design.

When she tried the tangram design cards and pieces, she was unable to do even the first card.

7. Math balance. When I put one weight on my side and asked Nikki to balance the beam with one weight on her side, she was unable to get the idea of which way to move. Finally, she pushed the beam down with her hand to compensate for the difference, then just began to swing it up and down.

Evaluation and Suggestions for
Learning Strategies Based on the Math Checks

Nikki has not yet achieved a one-to-one correspondence between number and object. Numbers appear to be just words to her. When she counts, she counts the spaces between objects as readily as the objects themselves. Matching is also done in a random manner.

When Nikki was asked to order the strings, she didn't take into consideration the relationships of size at all and just laid them end to end.

Conservation of continuous quantities was clearly beyond her scope, since she was still relying on visual perception for her information.

The checks involving class inclusion, which imply logical thinking, were also too difficult for this child who relied on visual information, and what she saw was more boy cards and more orange beads.

Nikki's inability to sort and classify the flower cards is characteristic of a younger child. Here, instead of working out a logical grouping, she focused entirely on "what looks nice together."

The patterns and spatial relationships involved in the parquetry and tangram designs were again beyond her scope. She was unable to do any but the simplest design.

Likewise, the logic of the math balance eluded her. (Many four-year-olds can balance with one weight.) Nikki was totally unable to discover any relation between the position of the beam and the position of her weight.

Nikki is clearly in the preconceptual stage of preoperational thinking. Again, I must ask whether possible brain damage is responsible for this retardation. I am also concerned with Nikki's inability to see patterns and with her predictable miscounting. I wonder whether she also has the additional liability of difficulty in visual perception.

An important part of making an effective learning strategy for Nikki will be some further checking by the school psychologist. In the meantime, it seems evident that Nikki should have limitless opportunities to learn to order her world. These should include many types of one-to-one matching (children and chairs, paint cans and brushes, etc.). Nikki should also be helped to sort and classify materials: pencils in the pencil box, pattern blocks by shape and color, people pieces, little scissors and big scissors. Ordering by size can be used: taller and shorter children, cutouts of feet, nesting boxes. All these activities will require her to participate actively and to manipulate materials, mostly in a framework of play.

Considering Nikki's verbal ability, she should be encouraged to talk about what she is doing, how she is doing it, and why. Perhaps she will make the most progress if we help her tie in her capacity for language with working out logical relationships.

One Year Later

Notes from October: "Lots of baby play in house corner with the fives; when they leave to do something else, sits on rug and sucks thumb. Did alphabet lotto with me--could recognize letters, but didn't get idea of sounds. If others join a game, ceases to concentrate and drifts away. In number lotto (matching dots to objects), had great trouble counting dots. Counted cubes and spaces in between."

In accordance with my plan for Nikki, I asked to have her checked by both the reading specialist and school psychologist. She was given the Slingerland prereading screening test to get additional clues on her visual perception. Her visual memory showed up as being very poor; she had great trouble holding an image in her mind. Her visuo-motor performance was also very poor. In copying geometric figures, such as triangles and squares, her age norm was that of four years, six months (Nikki was then six-four) --consistent with my findings last spring.

The psychologist tested Nikki with the McCarthy Scales of Children's Abilities. The analysis of her abilities was again consistent with the checks I used in the spring: Nikki showed normal verbal ability and fair auditory memory, but she had trouble with abstract problems, such as those involving categories. Her mathematical functioning was below average in all areas, and her motor coordination was extremely immature. The interesting point to me here was that Nikki had to actually pick up and move objects from one spot to another in order to count them and to perceive their shapes. The behavioral comments also provided me with some very helpful clues. The psychologist noted that Nikki approached problems without much confidence and stopped at the first sign of difficulties. Nikki seemed accustomed to being protected from any difficult situation and took it for granted that adults would "let her off the hook" if she pleaded tiredness. I recognized immediately that this had been true of my relationship with Nikki and that I had perhaps been expecting too little from her.

Encouraged by the psychologist, who checked into the classroom at frequent intervals, I began working regularly with Nikki at short tasks of matching, counting, category games (like sorting beads), and drawing pictures to match beginning sounds. In all these tasks, I tried to use Nikki's verbal ability to reinforce our activities by having her describe and explain to me what she was doing. Note from November: "Nikki shows progress, as our expectations are clearer. Today she counted paper cups (for milk) erratically for me. I said, 'Nikki, that's not right, and I know you can do better.' She looked surprised, and did."

Nikki continued to make gradual progress. Since she inevitably chose dramatic play in the house corner for the larger part of each day, I made an agreement with her first to use a game or material from the shelves each morning. She has needed a lot of help choosing and considerable firmness in expecting her to complete her activity and cleanup. I feel that my higher expectations of her have reinforced her own self-confidence: "If Nancy thinks I can do this, maybe I can."

In February, after lots of games and practice connecting sounds and letter symbols, Nikki made a "rhyming book" consisting of word families, which she thought up, traced (following my dotted lines), and illustrated. One page contained the word "man," with an appropriate drawing, the next "pan," and so forth. Each day Nikki reread her words, with the picture clues, before going on to think up her next rhyme. This provided a bridge to blending, and in March Nikki began writing a few lower-case letters and blending short-ă words from dictation. She continued to have directional and motor difficulties, and needed a model for her letters, but her progress was clear to both of us. Unless I worked with her alone, it was very hard for Nikki to keep focused on what we were doing, but I felt encouraged that she was beginning to be able to make this important step toward reading.

In March I gave Nikki the math checks I had used with her last spring. Although her attempts were more purposeful now, and she was able to do the first counting tasks accurately, she still was preoperational in conservation of number, ordering, conservation of continuous quantities, and class inclusion, was transitional in her use of the math balance, and her responses were characteristic of the preconceptual phase. She could do only the first two tangram cards.

In Nikki's case, it was helpful to me to have made a reading diagnosis, because it predicted more success in learning to read that I had anticipated. It was also helpful to have the objective opinion of the psychologist in developing strategies to use with Nikki. These two factors gave me the courage to expect and consistently require better performance from Nikki, with favorable results.

SYLVIA
(6 years, 2 months)

Reading Predictions Based on Classroom Observations

Sylvia is a competitive, bright little girl who is pushing hard to learn to read. She is the oldest of the five-year-old group, having turned six in the spring. She has soaked up all our prereading activities rapidly. She knows all her consonant and vowel sounds, can rhyme words, and has an excellent memory for words and songs. Her visual discrimination is fine, and her manual dexterity well-developed, as evidenced in weaving, painting, and scissor work.

Sylvia has a good vocabulary and expresses herself easily and frequently. If she doesn't understand something, she complains until she has it all straightened out, even if 25 people have to wait in the meantime.

Sylvia is extremely achievement-oriented. She is competitive, demanding, and curious. She is dependent on adults to a large extent, which is not

unusual, considering that she is the only child of success-oriented parents who have copious household help. It is really important to Sylvia to be perfect. If she makes an error, she weeps, but she picks herself up and tries again, with good concentration.

Considering Sylvia's ability and determination, I expect she will practically teach herself to read. In the meantime, we are practicing letter formation and blending three-letter short-a words both in dictation and reading. I anticipate no problems with Sylvia. I think she just needs to be given the appropriate tools and skills as she proceeds.

Diagnosis and Recommended Learning Strategies Based on the Reading Checks

Sylvia did well in most of the oral-language checks. Her sentence memory was only fair (typical of the group tested), as was her sound discrimination. However, her performance on the sound-discrimination check placed her on the dividing line between "medium" and "high." Sylvia's oral-language level (storytelling) was exceptionally good, though the rating doesn't indicate this--the most vivid, and containing the fullest descriptions of any of the children.

The visual discrimination checks were more difficult for Sylvia. She did well only on the word-matching check. Several reversals in her nonsense-word-matching test lowered her score. Reversals also impeded her selection in word recognition: she chose "dog" instead of "boy." She also worked hastily, which may be an indication of her style and account for some errors.

Sylvia's pattern memory was mostly good, with her blending check completely correct. Again, only fair performances in word recognition and sound discrimination lowered her total score.

Sylvia did well in all the visuo-motor tests. I was interested in how she executed the Bender Motor Gestalt designs. Even though she said it was "hard," she looked only briefly at each design, then reproduced it without looking back.

I must admit that I expected Sylvia to perform considerably better on these checks. One pertinent bit of information I hadn't caught before, or had noticed and dismissed, was her problem with reversals.

The second part of the checks--additional observations--help complete the picture of Sylvia. She is very good at listening, following directions, and concentrating, but is only fair at working alone with persistence and independence. A knowledge of Sylvia's background helps explain why. She is the only child of two professional and highly competent parents and is surrounded by adults (housekeeper, babysitter, cook), on whom she is very dependent. She is also overanxious about succeeding, which results in tears, not persistence, if she encounters obstacles. Nonetheless, Sylvia appears to be a very capable child, and she is highly motivated to learn to read and write. With her good language and visuo-motor abilities, I would expect her to make steady progress.

In order to increase Sylvia's skill in pattern-matching, she should be encouraged to use pattern blocks, tangram cards, puzzles, and parquetry designs next fall.

Sylvia also needs continued instruction in forming her letters, with care that reversals don't creep in. This can be done in a small skills group of three or four children having similar needs. Sylvia is also ready for more practice in blending, which she does well. The various short-vowel and consonant blends could be used, with emphasis on Sylvia's noting sameness and difference herself (as between fast and last, or hut and hit). Word families can be formed, with the suggestions coming from the children. Sylvia enjoys "rhyming," so this should be fun. Sylvia is also ready for selected new sight words, which will give greater variety in her reading and writing. Some of this can be done in the small skills group, some on an individual basis on Sylvia's own initiative. She likes dictating stories and should soon be able to copy her own text and read it back. By the middle of the year, she should be able to write her own simple stories, illustrating them with drawings and asking for new words when she needs them. In this way I expect her continuously to enlarge her store of words for reading and writing. Sylvia will probably enjoy reading aloud from beginner books and can be encouraged to read to an older child in an informal way. I don't plan to spend much time having her read aloud to me, as I don't think that is my most valuable function. She will get this largely by herself, since she is so motivated to read; besides, I think learning on one's own is highly desirable. So I plan to concentrate on helping Sylvia with her skills through writing: forming words, dictating sentences that are in turn read back, recording experiences in the classroom, and writing stories. Writing seems to be a more difficult medium for most children than reading, but with the development of writing skills reading seems to follow naturally and almost spontaneously, with the joy of discovery. I anticipate that this will happen with Sylvia.

Math Checks

1. One-to-one correspondence and conservation of number. Sylvia matched and counted simultaneously to make her pile of objects equal mine. When I spread out one pile, she knew it was still the same number "because I counted each pile." She also knew the numbers remained constant when I hid the piles in boxes. To establish correspondence without counting, she quickly moved the pieces one at a time into two new piles until all the pieces were used up.

When we played "store" and traded objects for coins, she knew we each had the same amount "because you gave me a coin for each one of the things." The next time we played "store" I started with nine coins, and after I had spent six I asked her how many I had left in my hand. "You have three left in your hand"--no hesitation in replying. When I had spent these I asked, "With all the money you have, can you buy all the objects I have?" "Yes, because they're the same amount of coins as things."

Finally I asked her to make a pile of objects (B) to equal my pile (A), and next to make another pile (C) to equal pile B. Sylvia did this, and knew that piles A and C therefore had the same amount; however, she was unable to give me a reason for this.

2. More than, less than. Sylvia had no difficulty figuring out what three more than four was, or three less than 10.

3. Seriation. Sylvia first arranged the differing lengths of string in a random way. When I asked, "Is there a special way you can fix them?" she started again, using a baseline, and picked out the strings one at a time in perfect order, shortest to longest, very quickly.

4. Conservation of continuous quantities. We started with two identical glasses of water. Sylvia poured hers into a wide jar and told me, "You have more now because yours is taller." Then she poured her water back and agreed we had the same amount again. Next, she poured her water into three smaller glasses. "Now I have more because I have three jars and you only have one jar."

5. Classification and class inclusion. Sylvia had no difficulty using the terms "same" and "all" in the check using red and blue squares and red circles. She was clear that "all the circles are red, but just some of the squares are red."

In the check using cards of four boys and three girls, I asked her whether there were more children or more boys. "More children, because they're all children"--again, no hesitation.

The next check used nine orange and three blue wooden beads. I asked Sylvia whether there were more wooden or more orange beads. "More orange."

6. Parquetry cards and tangram cards. Sylvia worked with considerable concentration fitting the parquetry pieces to the design cards. She showed a good grasp of the spatial relationships involved. When she took a hard card she stuck at it with persistence. Using the three-dimensional patterns and cubes, Sylvia ignored perspective and built her designs in a straight line.

When she used the tangram cards and pieces, she worked quietly and confidently, observing the shape of the piece and the space and fitting the pieces in. She worked through card 8 in this purposeful way.

7. Math balance. In the first check, Sylvia matched her weight to my weight quickly.

In the second one, I placed two weights on my side and asked her to make it balance, using one weight. She did this by trial and error, but got it quite quickly.

In the third check, I placed one weight on my side and asked her to balance the beam using two weights. She was not able to solve this, but she moved consistently in the right direction.

Evaluation and Suggestions for Learning Strategies Based on the Math Checks

Sylvia appeared to be in the stage of concrete operations in almost all the checks. She showed a firm grasp of conservation of number. She was even able to figure out how many coins I had left in my hand, which was the hardest counting task for most of the children. Moreover, she did it immediately, with no hesitation, which is typical of children in the operational stage. She was also quick to solve problems involving the terms "more than" and "less than."

Sylvia also demonstrated an operational approach to seriation, using a baseline to achieve accuracy in her arrangement.

Sylvia was unable, however, to hold in her mind that the amount of liquid remained constant in the check for conservation of continuous quantities, for the perceptual evidence to the contrary was too strong. This is a good example of how a child can be fully operational in some areas but preoperational in others.

Sylvia was able to use class inclusion in the experiment with the cards of boys and girls. There was no hesitation in her reply, and she was able to give a reason for her answer, "They're all children."

The next check, using wooden beads, was beyond her grasp. It would be interesting to present this experiment again in the fall to see if she is yet able to use the principle of class inclusion in this task.

Sylvia's approach to the design cards was also operational. She didn't work in a random way, but considered the shape of the space and the shape of the pieces and fitted them in carefully.

Although Sylvia was unable to solve the hardest problem on the math balance, she held on to the idea of the right direction to move, which I consider operational.

Sylvia seems to be ready for some structured learning situations. She might enjoy beginning to work with Cuisenaire rods, first by length and color, next by movable number values to express number relationships. She could try a variety of measuring projects, first using measuring units of her own choice and later standard measures. Sylvia also appears to be ready to begin some of the simple attribute games, using a variety of materials for sorting and inclusion. Structural games, such as the "10's game" and chip-trading, will give her opportunities for computation and familiarity with other bases.

When Sylvia expresses interest in recording, she can be taught to use a variety of symbols according to her need. Signs for "greater than" and "less than," arrows suggesting operations, and written sentences ("The rug is 12 books wide") can precede the use of addition and subtraction signs.

Besides this, Sylvia will continue to have many chances to experiment with materials and learn about relationships through informal classroom situations.

One Year Later

Reading predictions based on diagnostic checks have turned out to be considerably more accurate than my own expectations of Sylvia's success, which were based solely on my observations. After her rapid start in prereading skills, Sylvia slowed down. When I checked her reading after the summer

vacation, she had made absolutely no progress; in fact, she had forgotten a lot (unlike most other children, who continue to pick up clues). Furthermore, although she was definitely interested in learning reading skills, she displayed no initiative in doing this for herself. Notes from October: "Complains can't find anything to do. Seems anxious. Seeks out undemanding house-corner play. Follows Barbara around. No independence. Loads of reversals in her writing. Phonics are insecure. Rods--slow matching."

I tried to counter Sylvia's difficulty in getting started on things by helping her begin small projects in weaving, clay, and so forth. This helped some, but she continues to take her cues from her friends' choices and copies their activities.

Early in the fall I began working regularly with Sylvia in a small group, practicing handwriting and blending three-letter words using all the short-vowel sounds. I also gave her individual assignments to practice copying the letters she commonly reversed. In spite of this, her reversals have persisted, though she is developing the ability to locate and correct them.

I continued to work with Sylvia in small groups (with the groups changing according to the skill we were practicing). I felt that group work was beneficial, as Sylvia had trouble retaining directions or dictated sentences. (Note only fair sentence memory.) During the winter we practiced consonant blends, some vowel combinations, and words ending in silent e. Sylvia became increasingly interested in writing her own stories, spurred on by imitation of her friends. This gave a boost to her understanding of reading and writing, and she particularly enjoyed reading her stories aloud to her classmates. Sylvia also began to read beginning books on her own and obviously derived pleasure from her ability to do this.

In the early spring the focus of our work changed to reading aloud, since Sylvia tended to read word by word, with no flow or phrasing. I also asked her to write resumes of what she had read or answer questions about it, since she frequently read with little comprehension. Sylvia's work is certainly up to grade-level norms, but it is in definite contrast to what I thought she would accomplish.

The same is true in her math. Whereas reading predictions were excellent, math predictions based on the checks had a lower correlation with Sylvia's performance this year. It's as if she had reached a peak in her fifth year and spent the next year catching up.

According to my plan, I introduced Sylvia to Cuisenaire rods. I would show her various patterns or games, then ask her to work on her own to make other patterns. After Christmas she began copying down her patterns, using crayons to indicate the colors. I encouraged her to do this, since otherwise she chose no math activities voluntarily. I included her when other children were involved in weighing, measuring, and so on, but she wasn't too interested. When I introduced math symbols to her in early spring, thinking she was ready for this step in her notations, she showed confusion. I was intrigued to see whether her concept of class inclusion correlated with this, so I checked her with the experiment using orange and blue beads. She was convinced there

were more orange than wooden beads (unlike most of the other six-year-olds, who thought it was a pretty silly question: "Couldn't I see they were all wooden?").

One of the implications for me in following Sylvia's progress has been the importance of objective evaluations and the need to reassess all the children one is working with several times a year. The tendency to expect children to conform to one's own expectations can be insidious and can color one's interactions with the child. It seems particularly important in an informal classroom to know where the child is on the basis of what she does, not on what the teacher expects.

"This year I finished learning how to read. I was proud of myself, but sometimes it took too long to sound out the words so I just looked at the pictures." (Age 7)

CONCLUSION

In reviewing my study I am struck by the artificiality of trying to separate math and reading from other activities in our classroom. It is particularly difficult, not only because math, reading, writing, science, and the creative arts all overlap naturally, but also because the teacher in an open classroom is on the lookout for the various possibilities inherent in any activity. Growing a plant from seed may lead to drawings, a journal describing the life cycle, measurements and growth charts, stories about what it would be like to be a plant, creative movement, and so on.

Although in practice all these elements overlap in an integrated way, it was a necessary discipline for me to endeavor to separate out the abilities basic to math and to reading. Having checked these in the group of five-year-olds, I became interested in seeing whether the tasks I used for diagnosing readiness in math and reading had a pattern of overlapping areas. Even though there was some correlation of abilities at the top and bottom ends of the scale, I could find no general parallels between math and reading abilities in this small sample.

Furthermore, I could find no pattern in the order in which the mathematical concepts were achieved, with one exception: seriation preceded conservation of number. There were a number of factors that might have affected the outcome of the math checks. One was the difficult task included under conservation of number that required the child to deduce the number of coins left by remembering the amount traded the previous time; another was the simplicity of the class-inclusion check (a better picture might have included averaging responses to several different inclusion checks); also, the seriation check could have been made more difficult by inserting additional items after the initial group had been ordered, as I did one year later. Even so, the fact that one child achieved operational concepts of conservation of continuous quantities while being transitional or preoperational in most of the other checks lends credence to the view that absorption in manipulating certain materials may cause concepts related to that experience to emerge at an earlier time.

The absence of patterns underlines one of the central ideas in open education, that each child needs to be considered individually because different children arrive at points of readiness at different times and through different routes. If the checks are looked at in this light, they give the teacher a great deal of information about the child. The math checks were particularly useful for indicating where a child was at present in his thinking. They were less accurate as predictors, since there seems to be so much variability in how and when concepts develop. They were helpful as diagnostic aids because they pointed up areas of inexperience or confusion I had overlooked and suggested activities the child should be encouraged to engage in. I was particularly interested in the close correlation of the class-inclusion check with the child's ability to use mathematical symbols. That there were so few children who had reached this point of readiness underlines the need for continued emphasis on the use of materials and de-emphasis on written math until the age of seven or eight (or whenever these concepts have been attained).

The math checks most useful with five-year-olds were the ones involving conservation of number, seriation, and class inclusion. The tangram designs showed a great deal about a child's spatial sense and problem-solving techniques, but many other classroom materials, used informally by the child (and observed by the teacher) yield the same information. The same is true of the math balance; observation of the child in action with various balances, if the equipment is available for free play, shows his concepts of balancing. More important than having specific checks is learning what is essential to look for. Trying to define these elements was one of the central aims of my study.

As the children became older, I found that other math checks were also useful. I used tasks involving conservation of continuous quantities, more difficult inclusion checks, and conservation of length and area informally with six- and seven-year-olds to help determine areas of readiness. I usually found that the checks verified what I had observed and gave me the courage to let the child have all the time he needed for explorations (even against parental pressures: "Why isn't he doing written problems?"). The checks also kept my expectations realistic, especially with children who might be forging ahead in other areas, such as painting or reading, but who were on a different timetable with their math concepts.

Like the math checks, the reading checks were also excellent for diagnosis. They pinpointed each child's strengths and weaknesses, so that learning strategies could be individually planned. They also turned out to be helpful in predicting the child's learning style. In fact, the reading checks proved to be considerably more accurate that my classroom observations, in terms of predictions. They had the positive effect of leading me to have more realistic expectations of two particular children: the one at the bottom and the one at the top of the scale. Furthermore, by stressing the children's abilities I was also better able to focus on their particular needs.

The checks I found most useful (and the ones I have used with new children in the classroom this year, for quick diagnosis) were picture-naming, sentence memory, sound discrimination, and word-matching, as these indicated the child's grasp of categories, his aural memory, his auditory discrimination, and his visual strengths. The information yielded by oral-language and visuo-motor checks is easily picked up by observing the child in the classroom. (In a more formal classroom, where conversation and movement are limited, such checks would probably be necessary.)

I learned a great deal from studying, learning to give, and evaluating the reading checks. It required me to isolate the many factors that are presented in the integrated process of reading and gave me specific information for answering many of the questions I had about why certain things worked with certain children and not at all with others. Furthermore, the checks helped put that information into categories, thus enabling me to see patterns. With this schema, I now have a much better idea of what to look for in children's reading abilities, and I can also do much of the checking informally, without set checks. How a child copies a pegboard design, for

example, tells me a great deal about his visual discrimination and pattern-matching; how he draws tells me much about his visuo-motor organization; how he uses attribute materials gives information about categories and pattern memory; how he plays phonics games shows his auditory ability.

The open-classroom teacher should ideally have the diagnostic tools to check the children informally and the flexibility to adjust to individual needs. There seem to be times when a child learns best on his own, motivated by his own curiosity and explorations. There are other times when a child is ready for learning a particular skill or is bogged down and anxious about his abilities and needs careful support and teaching. I feel that some form of diagnostic checks, coupled with classroom observations, can help the teacher work more effectively on the basis of individual strengths and weaknesses. However, since there are so many unpredictable factors, such as anxiety or fatigue, checks should be used flexibly and be repeated at various times for additional information.

Although this study has focused on math and reading, the explorations and learning that take place through painting, movement, dramatic play, music, science, and group interaction are all essential in the development of the child. These elements are woven into each day, in varying proportions for different children depending on individual interests. Following through on a child's growth in math and reading has helped me become more objective in my evaluations, but I think that if I chose two different areas (such as work with clay and dramatic play) I would learn as much about the child. It is important to me to try to see the child as a whole in his daily life at school, involved in many different activities, and to help him (when he needs it, wants it, and is ready for it) explore new avenues of growth and learning.

"I am making a building with my friend in the hall." (Age 6)

Appendix A

A DESCRIPTION OF THE READING CHECKS

Many of these reading checks, together with guidelines for scoring, were suggested by tests in Jansky and de Hirsch, Preventing Reading Failure (1972), and I adapted them for individual use in my classroom.

1. Oral Language

For the first check, I used five pictorial story cards (a child getting on a bike, riding, falling off, crying, being comforted). I asked the child to put them in some order and then tell me what was happening. I tape-recorded the stories so as to note vocabulary, sentence structure, and ability to sequence events. Scoring: "high" (good organization and vocabulary); "medium" (difficulty with one of the above); or "low" (unintelligible).

The next check required the child to name a series of 20 pictures to give some idea of his noun retrieval. I cut out line drawings of familiar objects or occupations (hamburger, mail carrier, etc.) and pasted these on cards for the child to identify. Scoring: "high" (a total of 15 or more correct answers); "medium" (8-14 correct); or "low" (fewer than 8 correct).

Category-naming, a cognitive check, required the child to answer such questions as: "What are all these things: purple, red, yellow?" (colors); "Apples, pears, oranges?" (food, or fruit); "Hammers, screwdrivers, saws?" (tools); "Guitars, drums, violins?" (musical instruments, or things to make music with). Scoring: "high" (all correct); "medium" (2-3 correct); or "low" (fewer than 2 correct).

The check for sentence memory required the child to repeat each sentence exactly as it was spoken. (This also involves auditory discrimination and memory.) "I want two teddy bears"; "Anne has lots of fun playing baseball with her sister"; "Jimmy has made a fine wagon for his toys out of wood scraps." Scoring: "high" (all repeated word for word); "medium" (first 2 sentences repeated word for word); or "low" (1 or none correctly repeated).

2. Visuo-Motor Skills

Pencil use was noted, as well as the child's ability to write his name correctly. Scoring: "high" (proficient); "medium" (some difficulty); or "low" (writes awkwardly or with severe difficulties).

The first six Bender Motor Gestalt cards were used, and the child was asked to copy the geometric designs. I made no attempt to score these in proper clinical fashion, but merely noted the child's coordination and ability to make a recognizable facsimile of the designs. Scoring: "high" (all 6 designs executed clearly and spaced properly; "medium" (4 or 5 designs executed clearly); or "low" (fewer than 4 designs executed clearly).

3. Auditory Discrimination and Perception

The check for sentence memory overlaps auditory and language areas.

The check for repeating tapped patterns required the child to copy the following sequences:

loud - soft

soft - soft - loud

loud - soft - loud - soft

loud - loud - soft - soft - loud

Scoring: "high" (all correct); "medium" (3 correct); or "low" (fewer than 3 correct).

The sound-discrimination check consisted of saying 20 pairs of words to the child and asking him to indicate whether they were the same or different. Some word pairs were identical; others varied in initial consonants, final consonants, or medial vowels. (It is important to note in which area a child may have difficulty).

red - red	sip - ship	pot - pot
fin - thin	den - ten	man - can
rock - rot	home - home	hum - hug
run - run	bat - bad	much - mush
pan - pan	pan - pen	hit - hat
beg - big	luck - lock	but - bet
cup - cap	net - net	

Scoring: "high" (17 or more correct); "medium" (10 or more correct); or "low" (fewer than 10 correct).

The check for blending required the child to combine sounds into words, such as u-p, m-y, s-at, f-an, n-ot, c-ane, f-ail, ch-ime, c-a-t, b-i-g. Scoring: "high" (5 or more correct); "medium" (3-5 correct); or "low" (fewer than 3 correct).

4. Visual Discrimination and Perception

I made up ditto sheets, similar to those in many workbooks, that required the child to circle pairs of identical words. There were 12 sets of six words, organized in rectangular groups or boxes, such as

in	to	can	the	was	if	him	go
the	in	was	look	as	saw	his	the
if	this	on	can	man	was	you	him
on	to	here	go	me	we	of	if
can	the	the	you	my	the	was	saw
of	on	here	can	to	me	of	is
you	go	we	me	the	it	is	it
the	look	we	the	in	if	in	was
up	you	if	here	the	here	if	is

Scoring: "high" (9-12 correct); "medium" (6-8 correct); of "low" (fewer than 6 correct).

Nonsense-word-matching required the child to match words by configuration. I made ditto sheets up of nine sets of incomplete words and asked the child to circle all the "nonsense words" on a line that matched the first one in the left-hand column.

oc	co	co	oc	co
ti	it	ti	ti	it
num	num	mun	num	mun
dob	bod	bod	dob	bod
rin	nir	rin	rin	nir
fot	fot	tof	tof	fot
pag	gap	gap	pag	gap
soz	soz	zos	soz	zos
wem	mew	mew	wem	wem

Scoring: "high" (all correct); "medium" (5-8 correct); or "low" (fewer than 5 correct).

The last task required the child to recognize two words taught by sight. The words used were "boy" and "train." I printed these on index cards and "taught" them to everyone in the group to be checked. At various intervals

later in the day I showed each child a set of 10 cards with the following words printed on them: "cat," "dog," "frog," "snail," "treat," "man," "toy," "claim," "boy," "train." I asked the child to pick out the words "boy" and "train." If the child identified the words correctly, I removed the cards and asked him to write them. Scoring for word recognition: "high" (finds both words); "medium" (finds one word); or "low" (finds neither word). Scoring for spelling: "high" (both words spelled correctly; "medium" (several letters written); or "low" (up to 2 letters written).

5. Pattern Memory

Scores from checks on blending, word recognition, spelling, and sound discrimination were combined to obtain a diagnostic picture of this ability, which requires the child to hold patterns in his mind and recall them.

In the second part of the checks, the classroom observations, I attempted to rate the following either "high," "medium," or "low": ability to listen, ability to understand directions, ability to concentrate, ability to work independently, and motivation to read.

Appendix B

A DESCRIPTION OF THE MATH CHECKS

1. One-to-one Correspondence and Conservation of Number (based on ideas from the Nuffield Mathematics Project, Checking Up 1, 1970, and adapted for my classroom)

I made a pile of 12 objects and asked the child to make another pile having the same number, drawing from a pile of 20 objects. When he had done this, I spread my pile around and asked whether I still had the same number. Next, I asked, "Is there another way to know the piles are the same without counting?"

Then we played "store," trading play coins for objects. When we had traded nine times on a one-to-one basis, I asked, "Do you have as many coins as I have objects?" (This requires the child to abstract the notion of two equal sets.) Next, I purchased six objects and, holding the remaining coins in my hand, asked, "With all the money you have, can you buy all the objects I have?"

The last check required the child to make a pile (B) to match my pile (A) of 12 objects. Next, he matched a third pile (C) to pile B. Then I asked whether piles A and C contained the same amount. For some reason this check was simpler than several of the preceding ones, perhaps because the child could be making intuitive correspondences without true operational understanding, since the piles were all visible.

2. More Than, Less Than

I supplied the child with counters, then asked him to tell me how much 2 more than 4, or 3 less than 8 (and so on) was. Since this is an operation on numbers, it is difficult or impossible for children with a shaky notion of conservation. (I had previously worked on activities that used the terms "more than" and "less than" in an effort to make sure that the child was familiar with the language involved.)

3. Seriation (based on ideas from Checking Up 1)

I cut a string into 10 pieces, each varying about 1/2 inch in length, and asked the child to arrange them. I did not say "according to size." (This check would be improved by asking the child to order eight strings, then giving him the last two to insert in the completed arrangement.)

4. Conservation of Continuous Quantities (based on Piaget's experiment)

I gave the child two nearly identical glasses and asked him to fill them with the same amounts of water. Then I asked him to pour the water

from "his" glass into a low, wide jar. I asked, "Do we have the same amount now, or does one of us have more, and one of us have less?" The child then poured the water back into his glass. Next, I asked him to pour his water into three small glasses, and repeated my former question.

5. Classification and Class Inclusion (based on Piaget's experiments)

a. "Some," "all." In order to be sure that the child understood the use of these terms, I gave him four red circles, three red squares, and three blue squares. After each child had a chance to sort these, I asked, "Are all the squares blue?" "Are all the circles red?" "Are some of the squares red?" and so on.

b. Experiment with cards showing four boys and three girls. I first asked the children to sort (classify) them. When the sorting was finished, I asked whether there were more children or more boys.

c. Experiment with wooden beads. (This proved to be a more difficult check on class inclusion and probably shouldn't be tried until a child has achieved some measure of success on tasks a and b.) I took nine orange wooden beads and three blue wooden beads, identical except for color. I asked the child what they were made of. When we had agreed on this I asked, "Which are there more of, wooden beads or orange beads?" If the child answered, "Orange," I asked, "Do you remember what my question was?" If he had forgotten, we again discussed the fact that the beads were wooden, and I repeated the question.

6. Parquetry Cards and Tangram Cards

I first gave the children design cards made to use with geometric parquetry pieces. These used colors matching the pieces for cues, but still required the child to arrange two triangles, for example, to form a rectangle. I next used designs in the perspective to go with colored one-inch cubes.

The last design cards were created by the Elementary Science Study (McGraw-Hill) to go with tangram pieces, which are outlines to be filled in with designated pieces that require the child to focus on spatial relationships.

7. Math Balance

This device is a balance beam with intervals on each side numbered from one to ten. Problems can be solved either by knowledge of addition and subtraction or by understanding the principles of balance. I asked the children to do three progressively more difficult tasks, using the balance: first, to balance one weight that I placed on my side, with one on theirs (matching); second, to balance two weights on my side with one on theirs; and third, to balance one weight on my side with two on theirs. Since the child had to adjust two weights, instead of the single one in the previous check, while still taking into consideration the weight of each and the distance of each from the center of the balance, this proved to be a much more difficult task.

Appendix C

NOTES ON THE SELECTION AND USE OF
CLASSROOM MATERIALS FOR MATH AND READING

The materials in our classroom were chosen with several criteria in mind. The primary one was that young children learn best by actually handling, manipulating, and talking about materials; in this way many of their basic concepts are formed. The second one was that, owing to the emphasis on individual choice and on the child's taking responsibility for much of his own learning, materials should be adaptable for independent use with a minimum of teacher guidance. Third, materials should cover a wide range of activities and learning situations and provide avenues to tactile, visual, and verbal modes of learning. A personal note also entered into my choices: I felt the classroom environment should contain materials that were aesthetically pleasing, well-designed, and well-constructed.

When making this list, I was struck by the number of ways materials (which had originally been selected for particular math, science, or reading experiences) overlapped in their functions and use. I have marked these with an asterisk. I was also struck by the important part most activities contribute to language development, since the children freely discuss whatever they are engaged in with their friends.

In the outline of materials that follows, I have described the purposes for which materials were chosen as well as how adaptable they proved to be for independent use. The latter has been coded (1) = used independently by children; (2) = used independently by children after teacher help in how to use the material, and (3) = used mainly with the teacher, or with continuing help from the teacher by guiding independent work.

MATERIALS	PURPOSE	ADAPTABILITY FOR INDEPENDENT USE
books (constantly changing assortment)	picture books to look at; easy readers; research	(1) all children enjoyed picture books; most beginning readers enticed by easy readers
*attendance tags on name board	locate own name; read other names; count how many children present or absent	(1)
room signs	sight vocabulary; following directions	(1) readers liked to help nonreaders; new children soon knew all signs

MATERIALS	PURPOSE	ADAPTABILITY FOR INDEPENDENT USE
*music, art, sports lists with times	sight vocabulary; locating own name; time-telling	(1) used as above
*teacher-made blank books	dictating or writing and illustrating stories; beginning phonics; recording math discoveries; recording science projects	(1) and (2) each book is personal possession and creation of the child: much pride and interest in using and sharing
paper in various textures, colors, lined and unlined; crayons, paints, magic markers, craypas, colored pencils, scissors, paste, etc.	creative expression; pictures, paintings; stories	(1)
*cardboard, cloth, mystic tape for bookbinding	matching; measuring; area; manual dexterity; writing	(3) this takes constant teacher assistance but is still important to do
*class story books	children choose and copy own stories onto ditto sheets; run ditto machine (counting copies); collate (counting, matching); read everyone's stories	(3) teacher guidance needed, but lots of hard, independent work to copy and put together; much enthusiasm for reading finished book
reading area (rug, pillows)	a comfortable place to read and use quiet games	(1)
"play house" and "dress-ups"	dramatic play; verbal and nonverbal communication; freedom to express variety of "roles"	(1)
Ends 'n Blends (educational games)	phonics practice	(2)
Colet Alphabet picture and sound matching cards (Philograph Pubs.)	phonics practice; visual discrimination	(3) popular with fives

MATERIALS	PURPOSE	ADAPTABILITY FOR INDEPENDENT USE
Go Fish--consonant sound game (Remedial Education Center, Washington, D.C.)	phonics practice; visual discrimination	(2) popular with sixes
*Sound Hunt (American Teaching Aids)	phonics practice; categories; counting cards	(2)
*Consonant Lotto, Vowel Lotto (Dolch)	counting cards; matching; phonics practice	(3)
*various lotto games (Zoo, Alphabet, Objects, etc.)	categories; matching; visual discrimination	(2) popular with fives
parquetry pieces and design cards graded by difficulty, Set I, II, and III (DLM)	visual discrimination; spatial discrimination and organization; matching	(2)
*colored one-inch cubes and design cards (DLM)	visual discrimination; spatial discrimination and organization using perspective; counting and matching	(2) popular with sevens (used for free building by younger children)
*pegboards and design cards (DLM)	visual and spatial discrimination; counting pegs; matching colored pegs to design; manual dexterity (a good diagnostic material)	(2)
*varied colored beads and sequencing design cards (DLM)	visual discrimination: color, shape, size; matching, counting, sequencing (good diagnostic material for fives); manual dexterity	(2)
*playing cards	visual discrimination; matching; ordering	(1)
play clock	telling time	(1) (I don't think children can be "taught" to tell time; they suddenly just get the concept)

MATERIALS	PURPOSE	ADAPTABILITY FOR INDEPENDENT USE
clay	creative expression; mass; weight; shape; size	(1) and (2)
*puzzles	visual discrimination: shape, size, pattern, color; spatial relationships	(1)
*cooking ingredients	group cooperation; conversation; measurement; reading recipe; following directions	(3) teacher help needed with most children; sevens can cook on own by end of year
*math problem cards (mostly teacher-made), also Willbrook Discovery Mathematics cards	reading; following directions; solving problems on own; recording answers using symbols or sentences	(1), (2), and (3) variable participation; some children enthusiastic, others avoid
*Primary Lotto (SEE)	matching dots to numbers; visual discrimination	(2) popular with fives
*Net Results (Synestructics)	forming geometric structures; scoring points for figures formed; manual dexterity	(1) popular with sixes and sevens
Fractions Are Easy as Pie (Milton Bradley)	one avenue toward concept-building of fractions	(1) usually taught by older children to younger ones
chip-trading game (homemade)	trading in various bases; building concept of place value	(2) often taught by older children to younger ones
*Domodots (Cuisenaire)	a difficult game requiring visual discrimination, counting, matching, grouping numbers	(1) especially used by sevens
*Score Four (Lakeside)	developing strategies; developing directional and spatial sense and visual discrimination; matching; counting	(1) especially popular with sevens

MATERIALS	PURPOSE	ADAPTABILITY FOR INDEPENDENT USE
*Symmetry dominoes (SEE)	visual discrimination; symmetry	(1) popular with fives
carpentry	planning a project; measuring; motor skills	(3)
Invicta math balance (SEE)	exploring balance; solving addition problems	(1), (2), and (3) excellent for first explorations, then requires teacher input to suggest problems
pan balance (SEE)	exploring balance; weighing objects (like gerbils)	(1) and (2) lots of free play and experimenting; also used to solve weight problems by some sevens
free balance (unattached board on fulcrum)	exploring balance; finding center to balance board (good diagnostic tool)	(1) popular with all children in periodic spurts
trundle wheel (SEE)	measurement; especially for long distances like the hall	(2)
rulers, yardstick, tape measures	measurement	(2) in constant use
*dice board games (Parcheesi, etc.)	counting dice; matching moves with dice numbers; moving in consistent directions	(1) frequently taught by older to younger children
*Monopoly	place value; adding; subtracting; counting money; directional moves; logical thinking	(1) used constantly by a few older children, who teach each other
*checkers	logical thinking; directional moves	(1) very popular; taught by older to younger children
*Cuisenaire rods	visual and spatial discrimination; sorting, matching, and comparing; measurement;	(1), (2), and (3) equal amount of individual use and teacher input; teacher helps child find new use

MATERIALS	PURPOSE	ADAPTABILITY FOR INDEPENDENT USE
*Cuisenaire rods (continued)	beginning to think of numbers as groups; to solve problems in addition, subtraction, multiplication, division, and use of fractions; area; for checking own answers (such as game scores)	and suggests activities child can then pursue on own initiative; widely used in my class
Dienes multi-base blocks	building by fives and sixes; trading in different bases; helps many children "see" place value; an excellent manipulative material	(1), (2), and (3) equal amount of individual use and teacher input for place value (including teaching dice games); fine for free building
*Attribute blocks (SEE)	matching; sorting; classification; talking about this; sets and intersection of sets; visual discrimination	(3) mainly used with a teacher, though some children make up own games
Geoboards (SEE)	problems of area and perimeter	(2) used especially by a few sevens after discussion of possibilities
*Tangrams (SEE)	matching; spatial relationships; visual discrimination	(2)
*Pattern blocks (SEE)	sorting; matching; making or copying designs; symmetry; area; enlarging shapes and recording progressions; used for math and reading	(1) and (2)
*play money	used for playing "store"; counting; writing signs and checks to draw money from "bank"	(1)

MATERIALS	PURPOSE	ADAPTABILITY FOR INDEPENDENT USE
Unifix cubes; trays; number board; Tens Tracks (Philograph Pubs.)	counting; matching numbers and cubes; ordering trays; grouping by tens	(2) popular with fives and sixes
Kalah	counting; logic	(1) often taught by older children to younger ones
*sand table	weight; volume; properties of wet and dry sand; building; dramatic play	(1)
*water table (alternated with sand)	capacity; comparison of volumes; use of tubes to experiment with water pressure; dramatic play	(1)
*blocks	building; weight; shape; structural principles; dramatic play	(1)
Lego; Tinkertoys; Multi-rollway	patterns; spatial relationships; structural principles; measurement; manual dexterity; dramatic play	(1)
*Inch by Inch (SEE)	measurement; counting; matching; reading measurement cards	(1)
The 10's Game (Garrard Press)	counting; computation	(2)

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